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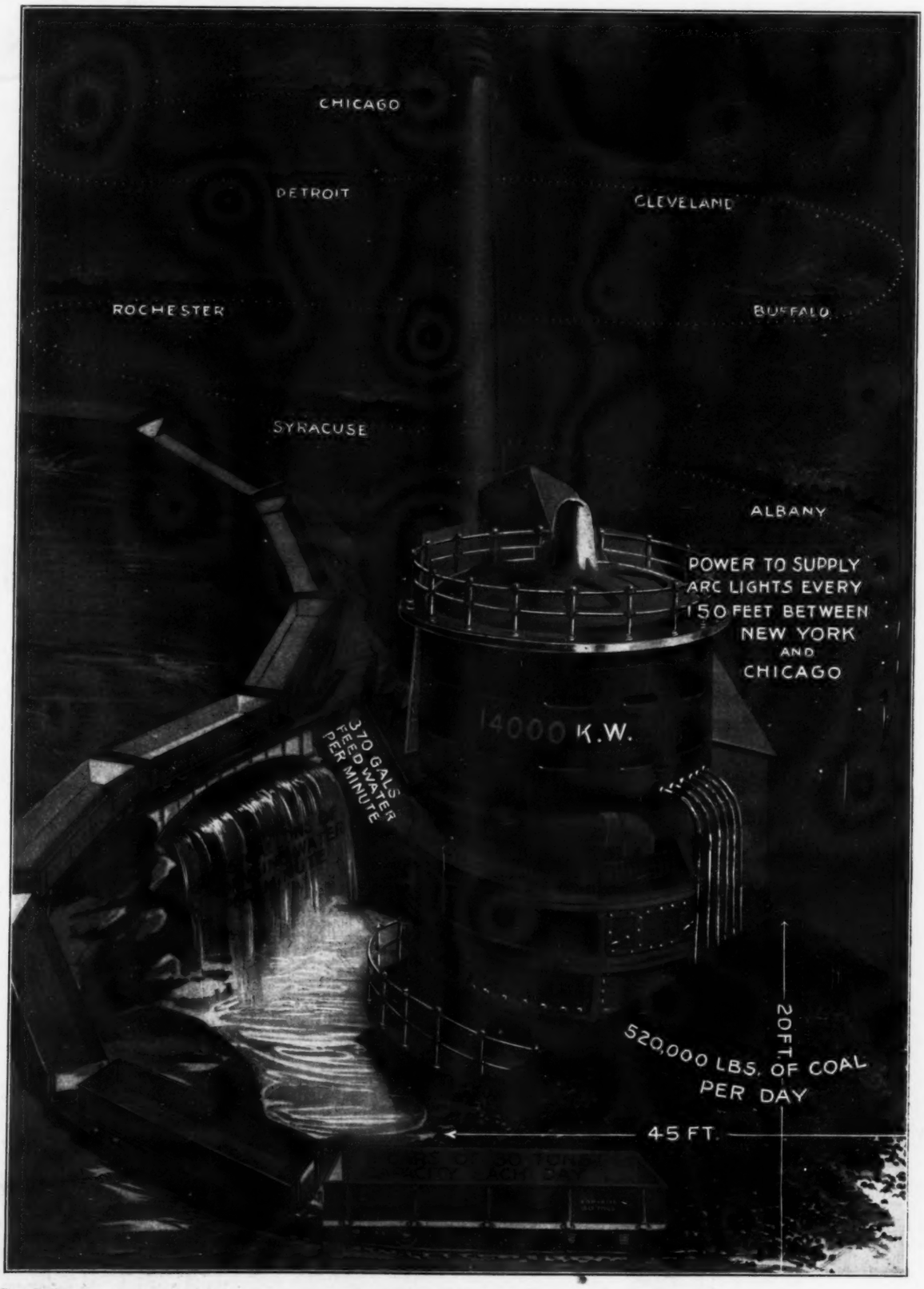


From Power.

WHAT 14,000 KILOWATTS MEANS.

WHAT 14,000 KILOWATTS MEANS.

A GRAPHIC COMPARISON.

THE General Electric Company is making some Curtis turbine-driven units of 14,000 kilowatts capacity. It will be interesting to see what this means in terms which appeal to the comprehension.

The fifth-stage rotating element shown herewith is 152 inches, or 12 feet 8 inches, in outside diameter and runs at 750 revolutions per minute. If it ran along the ground at this rate it would go 5.66 miles in a minute, or nearly 8,140 miles a day, and would run from New York to San Francisco in about 9½ hours. This and the other four wheels which constitute the moving part of the turbine, together with the shaft and rotating fields of the generator, weigh some 180,000 pounds, and yet so freely are they carried upon the cushion of oil that supports the step that this enormous weight can be revolved by one finger.

FIFTH STAGE ROTATING ELEMENT OF 14,000-KILOWATT CURTIS TURBINE.

Even at the low rate of 13 pounds of steam per hour per kilowatt this unit would require 182,000 pounds of water evaporated into steam each hour to supply it when running at its rated capacity, which would make a 14.3-foot cube. The day's supply would fill a pond 28 x 50 feet to a depth of over 5 feet, and at the usual rate of $1.50 per thousand cubic feet would cost over $105 per day. At the 75 pounds of condensing water often furnished per pound of steam condensed, it would require 3,640 cubic feet per minute, or as much water as would issue in a jet one foot in diameter, with a velocity that would carry it to a height of over 90 feet; or as much water as would flow naturally over a weir or dam in a sheet a foot thick and over 18 feet long.

It would take to make the steam to run this turbine, supposing one pound of coal to evaporate and superheat 84 pounds of water, 520,000 pounds, or 260 tons of coal per day. This would make a cone 45 feet in diameter on the base and 20 feet in height, and would take a train of nine 30-ton cars for its transportation. Its cost delivered would be for the ordinary case somewhat around $1,000.

If all applied to lighting, the 14,000 kilowatts which this unit will generate would maintain about 350,000 16-candle-power incandescent lamps, which, if hung in a straight line, would supply ample illumination to 600 miles of hallways 10 feet wide; or would supply 31,000 arc lamps, which, if spaced 150 feet apart, would illuminate 900 miles of ordinary streets. Using the output of this unit for fan-motor service, 150,000 of these little machines could be kept going. The energy delivered at the terminals of the generator during a day's run at full load would be sufficient to melt a cone of copper 21 feet in diameter at the base and 100 feet high, or 400 miles of copper rod one inch in diameter.

The floor space required for the unit proper, including the condenser, which is inclosed in the base, is only about 440 square feet, or approximately 32 kilowatts per square foot of floor space. It will take two men to operate it and all its auxiliaries, not including the boiler-room equipment.—Power.

THE POTENTIALITIES OF THE AIRSHIP IN WARFARE.

FIELD-MARSHAL LORD ROBERTS and Admiral Sir Gerald Noel, presiding in succession at a meeting of the Royal United Service Institution, left no uncertainty as to their views regarding the potentialities of airships and aeroplanes in future warfare. The occasion was a lecture by Major B. Baden-Powell, late of the Scots Guards, in which, with judicial temperateness, he considered the whole question of the effect which airships were likely to have on naval and field operations. It is true that the subject was considered more from the military point of view, having reference more to the use of airships, rather than from the design standpoint, but it is as important for the designers of mechanical appliances to study the views of those who are to use the machines as to investigate scientific problems connected with their design. One point seemed to be clearly established throughout the discussion, and was given expression to by one of the makers of aeroplanes, and that was, that the ships intended for warfare must differ in important details from those required for recreation or for commerce. In the case of the aeroplane it is important that the structure of the planes should be so designed that a hail of bullets would do the minimum of damage to the planes, and, therefore, have the least effect on stability. Thus the fracture of a tension or compression member should not involve the failure of the whole plane. In the case of dirigible ships, again, it may be found desirable, as it is possible, to protect the propelling machinery from such bullets. As to the envelope, it seems to be accepted, as shown by experiments in Germany, that perforations by bullets of the gas bag should not greatly affect its carrying power, as, with certain material, the holes of themselves close up, while the amount of gas which escapes bears but a small proportion to the total.

Major Baden-Powell found, in the performance of the Zeppelin ship and existing aeroplanes, grounds for confidence that they could realize the requirements of the military officer in speed, elevation, and radius of action. He put the available speed at from 25 to 35 miles per hour, the height at 5,600 feet, and the radius at 360 miles, in the case of the airship; while, as far as aeroplanes were concerned, the greatest speed was assumed at from 40 to 50 miles, the maximum altitude so far attained 2,000 feet, and the greatest distance traveled 144 miles in 4 hours 17 minutes. As one of the speakers put it, what one has to consider is not so much what has already been achieved, but rather the possibilities of further advancement. The principal obstacle to the dirigible is the great size of the shed required for storage, but this may be overcome by utilizing such depressions as quarries throughout the country. The variation in temperature, too, involves a serious change to the lifting power. Thus a difference of 40 deg. F., which is not infrequent within twenty-four hours at almost any season, involves a change in the capacity for lifting of one-twelfth of the total, while damp and snow also create difficulties. As to the aeroplane, the gallant Major did not seem to place the same weight as others upon the inability of the aeroplane to hover over its prey, considering that by stopping the propeller the machine could be allowed to fall vertically, which would be equivalent to arresting progression, while the same result could be achieved, in the event of a strong wind, by turning the machine to face the wind. The dirigible, he agreed, in this respect has material advantages. Although the reduced density of the air at an elevation of 5,000 feet would require an addition of 20,000 cubic feet of gas to the volume required to lift the ship, a dirigible balloon could rise more quickly by discharging ballast, and could carry a greater weight of passengers and of ammunition, although half a dozen aeroplanes might do the same work and cost less. If the engine stopped, it would not be compulsory to descend, and for the same reason it could remain longer in the air without running the engines. On the other hand, the aeroplane was smaller, easier to manage on the ground, cheaper, more quickly made, more easily repaired in the field, was comparatively invulnerable, was not affected by atmospheric change, traveled faster, and presented a smaller target.

There seemed to be a consensus of opinion at the meeting against the overestimation of difficulties of aerial navigation even in darkness, and Col. Capper referred to the value of practice with balloons, whereby trained aerial navigators could pick their way with surprising facility in the dark and even in slight fogs. In this respect the dirigible has enormous advantages, especially when working on compass bearings. Major Baden-Powell gave some results as to the average velocity of the wind at various altitudes for this country and for Germany. At corresponding altitudes in Germany the velocity was considerably less. Thus at ground level the average for England was 13 miles per hour; at 1,500 feet, 28 miles; at 3,000 feet, 30 miles; and at 5,000 feet, 36 miles per hour. At Lindenburg, near Berlin, on the other hand, the rate at ground level was 11 miles per hour; at 1,500 feet, 20 miles; at 3,000 feet, 21 miles; and at 4,500 feet, 21 miles. The Zeppelin ship, therefore, seems to have the advantage in Germany. Col. Capper did not consider that such variations in the wind velocity at different altitudes materially affected the navigation of the air, as the wind was fairly constant at a given altitude, and the navigator naturally kept to this altitude, so that the navigation at night did not seem to raise any serious obstacle, even although the lights of towns in time of warfare were extinguished.

One utility of the airship or aeroplane is undoubtedly associated with reconnaissance work. Irrespective of the speed of travel, it is possible at great altitudes to discover opposing forces in a manner quite impracticable where the curtain has to be penetrated on the ground level. For practical reconnaissance work, 10 or 15 miles was considered a sufficient radius; and for strategical work, 40 or 50 miles, according to Major Baden-Powell. But Col. Capper differed from this view, believing that, as the radius of action was largely a question of fuel, it would be well to provide for very much wider range of observation; because it became of the utmost importance to a general to know what was proceeding, even in distant towns, in the direction of mobilization and movement of troops.

Aeroplanes would certainly be more useful for a raid, and indeed for movement of troops, than the dirigible ship; but it would be necessary, of course, to have a very large number of such aeroplanes carrying three or four men in addition to the driver. They would also be of considerable benefit for the carrying of despatches and communications, for duty with scouts, or for providing a coign of vantage for a commander-in-chief during action. There seemed to be some difference of opinion as to the extent of destruction which might be done by the discharge of explosives; but on this point the potentialities are sufficiently serious to justify very careful consideration. Much of what has been written, of course, is applica-

ble to naval warfare as far as reconnaissance work is concerned, although it is a point of doubt as to whether a destroyer with a captive balloon could not do better work than an aerial ship.

We will not follow Major Baden-Powell into the more speculative field, as to the advantage of duels in the air between two dirigibles, a dirigible and an aeroplane, and two aeroplanes. An aeroplane attacking a dirigible, it was thought would play the part of the hawk to the heron; and as to an encounter between two flying machines of corresponding type, the advantage, of course, would largely rect with the one having the greatest speed and power of attack. This raises the question of the possibility of arming airships, and of the most suitable weapon to use. Major Baden-Powell contemplates eventually the use of some form of pompon, and a missile of the nature of a dart, with knife-like barbs, in order to cut the envelope of the airship; while the application of various chemicals was suggested in order to set light to the hydrogen in the gas cylinder.

After all, however, the more serious problem from the national point of view is the means of defense against possible attack by airships, and it seems, in view of the undoubted activity of Germany in providing a fleet of airships, as if some systematic defensive measure were necessary. We must meet airship with airship, somewhat on the same principle that a battleship is built to meet the enemy's ship; and similarly it is essential that the enemy's country must be our line of frontier in the air as on the sea. It is therefore incumbent upon the Admiralty as well as the War Office to offer every encouragement to the designers of aeroplanes in order to arrive at the best results to meet all conditions which may obtain. At the same time it is equally important that land defenses should be provided, and these, it was generally agreed, should take the form of light rapid-firing guns, which could be readily fitted to the chassis of any motor car. These guns would require, of course, to have a very high angle of fire, in order to combat an airship traveling at an altitude of 4,000 feet or 5,000 feet. Aerial torpedoes, in the form of improved rockets, were suggested, as well as some form of aerial mines, suspended at short distances by small captive balloons, in order to protect zones over our cordite-supply factories and stores, over the great arsenals, and ship and ordnance-repairing establishments, and over points which would most likely be attacked because their destruction would most fully influence the maintenance of our forces.—Engineering.

MARINE PROPULSION BY ELECTRIC MOTORS.

THE PLAN OF MR. H. A. MAVOR.

A COMPARATIVE study of the methods of applying power on land to the propulsion of vehicles and other purposes, and of the methods adopted at sea, shows that, while the problems have much in common, there are differences in methods and in experimental results which have mutually interacted from time to time between land and sea practice, tending toward assimilation, with a gradual improvement in the economic results in both cases.

At first sight it would appear that on a ship the direct connection between the power generator and the propeller renders unnecessary the use of any intermediate transmission device, and so long as reciprocating steam engines were the best attainable power generators it was possible to correlate the speeds of generator and propeller so as to gain the best efficiency of each. The steam turbine and the non-reversible internal-combustion engine introduce a new set of conditions. On land the turbine holds the field for the largest powers, and because its speed of revolution is unsuited to any ordinary mechanical direct application of power for industrial purposes its evolution has been directly associated with electrical transmission. These turbines are, many of them, of the same order of magnitude as the turbines used on shipboard, and therefore a comparison of economy in the two conditions is inevitable.

Before the introduction of electric transmission the marine engineer had the more complete scientific data, and consequently the marine engine held the blue ribbon of economy which now belongs to the turbo-electric generator. Among the reasons for the higher efficiency of the land turbines are: That the engineer on land is freer than is the marine engineer to adopt a suitable speed of revolution; that the land turbine runs at approximately constant speed for all loads, and can therefore be run on the governor, rendering easier the application of superheat and augmented vacuum; that on land it is possible to subdivide the power units to meet the conditions of varying load, and thus maintain at the smaller loads an efficiency not materially different from the efficiency at the full load of the system; that at sea change of power is directly associated with change of speed, and the whole of the power units must always be in motion while the ship is in motion. The same engine has to run the ship at 10 knots and at 20 knots, although the power varies very widely between those limits. Also the high economy on land of power production associated with electric transmission is largely due to the possibility of exact measurement of power under all conditions of load, giving a complete knowledge of the effect of all changes in the apparatus or in the methods of working it.

In a paper read before the Institution of Civil Engineers H. A. Mavor makes the proposition to provide an electric equipment intermediate between the prime mover and the propeller, extending the limits of practical economy in each by modifying the restrictions which the prime mover and propeller impose upon one another, and providing that the prime mover may operate at or near the constant speed required for the attainment of maximum efficiency and full power, and that the power expended in driving machinery not required for work is reduced to a minimum or entirely eliminated. At full power all the elements of the generating plant are in full operation and the whole power resources can be concentrated on driving the ship. When full power is not required the generating plant may be shut down in sections.

To accomplish these ends special motors have been designed which give the necessary changes of speed and direction and permit of the advantageous combination or elimination of the power generators. These motors involve no new electrical principle, but simply mechanical adaptation of well-known electric designs. Alternating current alone is available for the purpose in question, and normal motors have therefore a fixed speed of rotation which is a simple multiple of the generator speed.

Two methods of speed change are proposed by Mr. Mavor, each associated with a new form of motor.

The principle of operation of the "Spinner" motor is that an ordinary normal motor driving the propeller at a fixed speed, with the shaft and propeller directly connected, is so arranged as to be rotatable as a whole about the propeller-shaft axis. This rotation is accomplished by a second motor concentrically arranged outside the first, so that the main motor system may be rotated in each direction—again at a fixed speed, which is a simple multiple of the generator speed—and the speed of rotation of the propeller shaft and of the propeller in the water is the algebraic sum of the rotation of the main motor and of the rotation imposed upon it by the auxiliary motor.

As both motors are reversible it will be seen that in each direction there are three speeds:

1. The speed of the main motor system: the middle speed.
2. The speed of the main motor system minus the speed of the auxiliary motor system: the low speed.
3. The speed of the main motor system plus the speed of the auxiliary motor system: the full speed.

The combination may be designed for any three-speed ratios, such as 1, 2, 3; 2, 3, 4, etc. Any intermediate speeds required are attainable by adjustment of the turbine or engine governor, which can be operated economically through a range down to about 75 per cent of full speed. The same method is applicable to non-reversible internal-combustion engines.

The "multiple" motor is an ordinary squirrel-cage induction motor in all respects, except that its stator is wound with two or more independent electric circuits, each associated with a separate source of supply of energy.

For example, the motor may be fed from two sources of supply at 25 and 50 periods respectively, the motor windings being for 46 and 92 poles. At full power and speed both windings are in operation under their most advantageous conditions; each of these windings results in a synchronous speed of 66 revolutions per minute. When the 25-period current is supplied to the 92-pole winding the speed is 33 revolutions per minute.

Either of these motors permits of one or more generators being used together in the same mechanical system without electrical connections or synchronizing devices.

Mr. Mavor then discusses the application of electric propulsion to certain definite types of ship, and also gives diagrams illustrating the saving in space obtained. The examples worked out are as follows:

(i) In a cargo vessel of 840 shaft-horse-power the normal reciprocating engine equipment with a single screw would weigh 570 tons for engines, boiler and fuel. The electrical equipment, consisting of three oil engines, three motors and three propellers, would weigh only 270 tons, including fuel. Further, with coal at $4.50 per ton and oil at $9.00 per ton, the saving in fuel cost on a total of $85 would be $26.50 per day at full power.

(ii) In a similar cargo vessel gas engines might be used. Taking an equipment of 770 shaft-horse-power, and using three gas engines and one multiple motor, the respective weights of the normal and proposed equipments would be 446 tons and 229 tons. The consumption of fuel shows an equally favorable comparison.

(iii) A third cargo vessel, but of 1,030 shaft-horse-power, is worked out for the purpose of illustrating the application of steam turbines to the multiple motor. One plant drives the ship under normal conditions: extra power is supplied by a small turbo-generator, and is used to keep up the ship's speed in heavy or contrary weather.

(iv) On a passenger vessel of, say, 16,200 shaft-horse-power, the electrical equipment permits of a subdivision of the plant, so that at ship speeds lower than the maximum only part may be run, and that at full power. This advantage is gained without loss in full-power economy, and without additional complication.

Luminous Paint, Showing White and Colored Lights in the Dark.—*a.* White: Mix Japan varnish 40 parts (Zanzibar or Kauri copal melted over a charcoal fire; 15 parts of the melted mass is dissolved in 60 parts of French oil of turpentine, then filtered and mixed with 25 parts of previously heated, but somewhat cooled linseed oil) with 6 parts of prepared sulphate of baryta, 6 parts prepared carbonate of lime, 12 parts of prepared white sulphide of zinc, 36 parts of luminous sulphide of calcium, and mixed in a suitable vessel or a receptable and then ground very fine in a paint mill. *b.* Red: 50 parts Japan varnish, 8 parts prepared sulphate of baryta, 2 parts prepared madder lake, 6 parts prepared red disulphide of arsenic, 34 parts luminous sulphide of calcium. *c.* Orange: 46 parts Japan varnish, 17.5 parts prepared sulphate of baryta, 1 part prepared Indian yellow, 1.5 part prepared madder lake, 43 parts of strongly luminous sulphide of calcium. *d.* Yellow: 48 parts Japan varnish, 10 parts prepared sulphate of baryta, 8 parts chromate of baryta, 34 parts of strongly luminous sulphide of calcium. *e.* Green: 48 parts Japan varnish, 10 parts prepared sulphate of baryta, 8 parts oxide of chromium, and 34 parts luminous sulphide of calcium. *f.* Blue: 42 parts of Japan varnish, 10.2 parts of prepared sulphate of baryta, 6.4 parts ultramarine, 5.4 parts cobalt blue, 36 parts luminous sulphide of calcium. *g.* Violet: 42 parts of Japan varnish, 10.2 parts prepared sulphate of baryta, 2.8 parts ultramarine violet, 9 parts arsenate of cobalt, 36 parts luminous calcium sulphide. *h.* Gray: 45 parts Japan varnish, 6 parts prepared sulphate of baryta, 9 parts prepared carbonate of lime, 0.5 part ultramarine blue, 6.5 parts gray sulphide of zinc, and 36 parts luminous sulphide of calcium. *i.* Yellowish brown: 48 parts of Japan varnish, 10 parts prepared sulphate of baryta, 8 parts auripigment, 34 parts luminous sulphide of calcium. For art purposes use in place of Japan varnish equal quantities of pure East Indian poppy oil. For oil color prints (chromos), in place of Japan varnish use equal parts of pure linseed oil (cold pressed and thickened by boiling); for glassware and porcelain, in place of Japan varnish use 10 per cent more Japanese wax, with one-fourth the quantity of olive oil.

REGISTERING LETTERS BY SLOT-MACHINE.

A NEW FRENCH AUTOMATIC CONTRIVANCE.

BY LUCIEN FOURNIER.

AUTOMATIC machines for vending postage stamps and postal cards are already in use in Paris, and a very ingenious machine for registering letters, the invention of Antal Fodor, has recently been installed at one of the postal stations.

A 25 centime piece is inserted in the slot at the right side of the machine (Fig. 1). The letter, bearing stamps sufficient for ordinary postage, is placed in the opening at the top, with the address side in contact with a plate which overhangs the opening, the handle is turned, and in a few seconds the letter is registered and a receipt for it falls from the tube marked "Reçus," near the bottom of the box, in front.

The mechanism is too complicated to be here described in detail, but a general idea of it can be given. The very original devices by which imitation coins are rejected and the registration proper is effected are especially worthy of mention.

The new French 25 centime piece is made of nickel, and the genuineness of the coin slipped into the machine is tested by taking advantage of the fact that nickel is slightly, and only slightly, magnetic. The coin, after it has been inserted in the vertical slot *O* (Fig. 2), which is just high enough to admit it, rolls down the inclined passage *A*, the sides of which are cut away to a height *E*, sufficient to cause any coin appreciably smaller than the genuine 25 centime piece

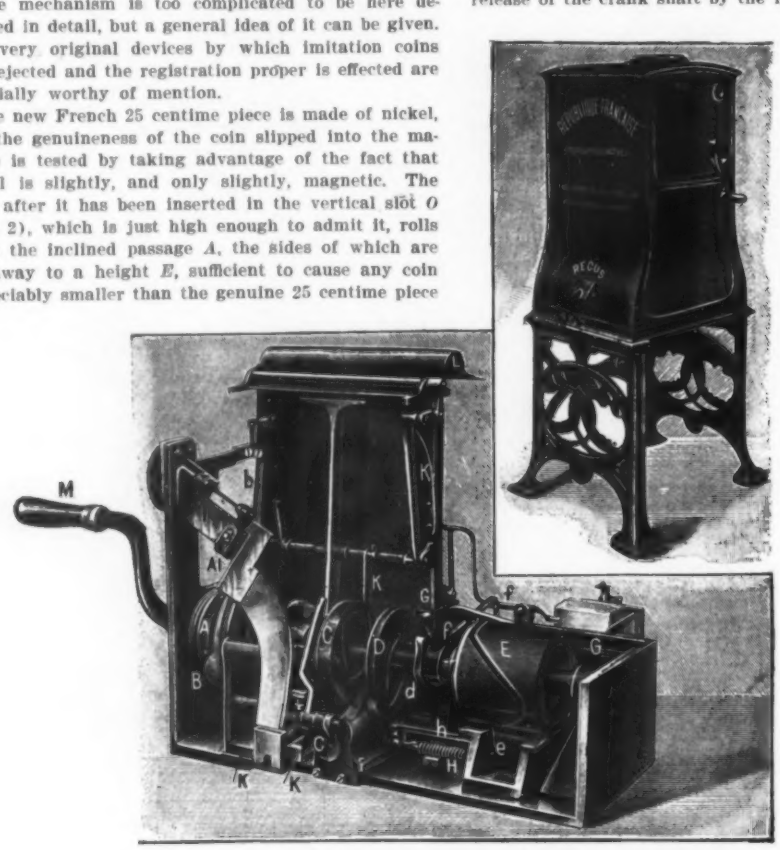


FIG. 1.—AN AUTOMATIC MACHINE FOR REGISTERING LETTERS.

to fall out laterally. After passing these tests for size, the piece comes within the influence of the magnet *A*. If it is of nickel it is deviated by the attraction of the magnet just enough to fall into the tube *F* and set the mechanism into action. If it is a piece of iron or steel it is attracted more strongly and stopped, so that it falls in front of the tube and is expelled from the apparatus. Finally, a piece of lead or other non-magnetic metal is not attracted at all, but continues its course unchecked to a passage which delivers it

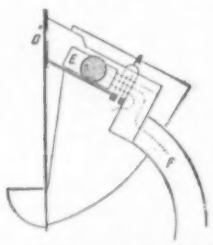


FIG. 2.—DIAGRAM OF COIN TESTING DEVICE.

outside the machine. This very simple device operates with perfect certainty.

The mechanism comprises three groups of organs, one operated by the coin, another by the letter, and a third by cams attached to the shaft of the crank. But the crank cannot be turned until it has been released by lifting the lid of the letter slot, and this lid cannot be lifted until the coin has been inserted in the coin slot. As the handle is turned the letter is raised to a vertical position and pushed into a corner, where the number and date are stamped upon it. Meanwhile a blank receipt ticket has been presented to another stamping machine, so that the date and serial number are stamped simultaneously upon the letter and the receipt. The ticket is delivered to the sender through the lower tube already mentioned, and the letter falls into a locked box from which it can be removed only by the official receiver of registered letters.

The system of stamping includes an ingenious device which makes it impossible to obtain a registry receipt by inserting a coin without inserting a letter. This result is accomplished by means of a rod which, pressed by the letter on its arrival at the proper position, releases a spring which sets in motion the stamping mechanism. If no letter is present, the mechanism does not work.

An interesting recent modification of the method of release of the crank shaft by the insertion of the coin is illustrated by Fig. 4. The coin falls into a receptacle *R* suspended freely from an axis *A*. The raising of the lid of the letter slot causes a rod *L* to enter a channel which extends horizontally through this receptacle. The rod, pressing against the coin, turns the receptacle on its axis and by this means releases the crank shaft, but if no coin is present the rod simply passes through the receptacle without moving it. Hence, even if the lid could be raised before insertion of a coin, the crank shaft would remain locked and the machine would not work.

This ingenious postal automaton effects the registration of letters very rapidly and with every guarantee of security. The ticket which it delivers (Fig. 3) serves as a receipt. The name of the addressee is subsequently written on the ticket by the sender. The possibility of error or fraud is completely eliminated. —La Nature.

RÉPUBLIQUE FRANÇAISE

POSTES ET TÉLÉGRAPHES

REÇU D'UN ENVOI RECOMMANDÉ DÉPOSÉ

sous le N° :

1909 JUL 29 I 001

dans l'appareil automatique du Bureau 11, à PARIS, rue Ste-Anne.

Nom et domicile du destinataire :

Scientific American
361 Broadway
New York
U.S.A.

AVIS : Les lettres non, ou insuffisamment affranchies ne seront pas expédiées.

FIG. 3.—A RECEIPT DELIVERED BY THE MACHINE.

FRENCH EXPERIMENTS ON THE EFFECT OF SHELLS IN NAVAL WARFARE.

THE French government has recently completed an interesting series of experiments on the effect of shells in naval warfare. An obsolete warship, the Iéna, was selected as the object of attack, and was anchored in the harbor of Hyerès, near Toulon. The attacking vessel approached within 500 or 600 meters (1,640 or 1,968 feet) and took aim with the greatest possible precision in order that its projectile should strike a particular part of the Iéna. The firing charge was not the regulation charge for the caliber and projectile employed, but was calculated to make the striking velocity of the shell, fired at this short range, equal to the velocity which it would have had, on striking, if it had been fired from a distance of 6,000 meters (19,685 feet) with the regulation charge. As a result of experiments which have been conducted during several years it was possible to calculate the reduced charge with almost perfect accuracy.

The attack was opened with guns of calibers of 140 millimeters (5.5 inches), and 194 millimeters (7.64 inches). These comparatively small shells were aimed at the thin armor of the casemates and at the unarmored parts of the vessel. The damage inflicted was considerable and, in some respects, exceeded all expectations. For example, bursting shells, which contained explosive charges equal to only 2 per cent of their weight, sufficed to start a conflagration in a casemate and to explode cartridges which had been placed therein.

Since the Russo-Japanese war, great importance has been attributed to the asphyxiating effects of explosive shells. The experiments with the Iéna were arranged to test this question. Dogs, rabbits and pigeons were placed in the casemates, gun turrets, and batteries. The search for exact truth was even carried so far as to attach, over the hearts of some of these animals, microphones which were connected with receivers on the attacking vessel, for the purpose of observing the physiological effects of the shots, but this refinement was soon abandoned, owing to the insignificance of the results obtained. To the great surprise of the officers, the dogs, rabbits and pigeons were found alive and uninjured, after most of the experiments.

The attack was continued by the Suffren, with guns of 305 millimeters (12 inches) caliber and with the new and heavy shells, weighing 440 kilograms (970 pounds) and containing 17 kilograms (37½ pounds) of melinite, which are henceforth to be used exclusively by French warships of the Danton type. The results obtained were very gratifying. The new shell proved to be adapted perfectly to the ballistic conditions for which it was designed, and its perforating and explosive effects were startling.

The sensitiveness of the exploding mechanism of shells was also studied in these experiments. Exploders of various types were used with shells of each of the three calibers employed. All of these exploders are based on the principle of centrifugal force and are placed at the rear end of the shell. They automatically set themselves in readiness for action when the shell attains its maximum velocity of rotation, at the moment of leaving the gun, and they cause the explosion when this velocity is suddenly diminished by the entrance of the shell into the armor of the vessel attacked. Hence their regulation is a very delicate matter, for they must not act on mere contact, and yet are required to act when the shell perforates a thin armor plate. Various exploders of this type, of French and foreign make, were tested, and valuable data concerning their relative efficiency were obtained.

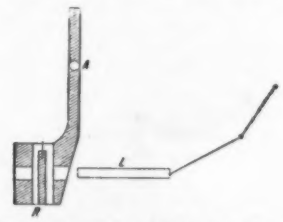


FIG. 4.—NEW DEVICE FOR RELEASING THE CRANKSHAFT.

In spite of this series of bombardments, the old Iéna is still afloat, and will be used for another course of experiments, in which the attacking vessel will be stationed at a distance of 6,000 meters (19,685 feet), and will use the regulation service charge.—Cosmos.

BOTTLED LIQUID GAS FOR BALLOONS.

LIQUID HYDROGEN AND ITS USE IN AERONAUTICS

THE greatest difficulty in the liquefaction of hydrogen consists in the construction of a suitable cooling device. In liquifying air the refrigeration obtained by the expansion of the compressed gas suffices, but in the case of hydrogen more energetic means are required, for the following reasons: Hydrogen has a very high molecular velocity and is one of the few

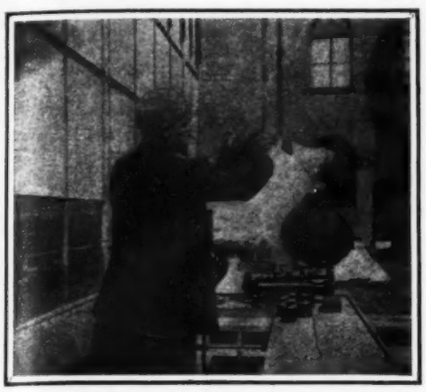


FIG. 1.—FILLING AND WEIGHING FLASKS OF LIQUID HYDROGEN.

gases which becomes warmer on escaping into a vacuum. This heating effect occurs at all temperatures above —166 deg. F. Hence the gas must first be cooled to this temperature before it can be liquified by expansion. This preliminary cooling is usually effected by the evaporation of liquid air in a vacuum.

According to Umschau, for the production of one liter (2.2 pints) of hydrogen Kamerlingh Onnes, the leading authority in the liquefaction of gases, found it necessary to employ 3 horse-power and 2 liters (4.4 pints) of liquid air. He then succeeded by means of an ingenious device in purifying the liquid to 99.9 per cent.

Liquid hydrogen is easily transported as its weight is only 1/15 that of water and its volume only 1/800 that of hydrogen gas. The handling and transportation are both convenient and safe. The process of filling and weighing the flasks of liquid hydrogen is shown in Fig. 1. The evaporation at the place of employment offers no difficulty. For small quantities the apparatus shown in Figs. 2 and 3, which was originally devised for the respiration of oxygen at high altitudes, may be employed. When the cock *h* is closed, a certain excess of pressure is produced in the vessel *V* which expels the liquid hydrogen through the sieve, *R*, into the vertical tube *ss'*, which ends above in the cylinder *E*, made of wire netting. Through this netting the liquid escapes into the metallic globe *K*, where its evaporation produces a strong current of gas.

FIG. 2.—SMALL APPARATUS FOR EVAPORATING LIQUID HYDROGEN.

For the transportation and evaporation of larger quantities of liquid hydrogen for filling balloons, the double-walled gas bag, shown in Figs. 4 and 5, is employed. The space between the two bags is filled with eiderdown.

As liquified hydrogen occupies little room and when evaporated possesses great lifting power, it appears especially suitable for employment as ballast instead of sand. In dropping sand ballast, the buoyancy of the balloon is increased only by the weight of the ballast dropped, but if hydrogen ballast is used the buoyancy may be further increased by the lifting power of the gaseous hydrogen which is turned into the balloon. With dirigibles of the flexible type the use of liquid hydrogen is still more promising. The dirigibility of these balloons is dependent upon the maintenance of their form by the distension of the gas bag, but as no bag is completely gas-tight, losses are unavoidable. Hence all dirigible balloons of the flexible and semi-rigid types are provided with interior gas bags called ballonets, which are filled with air and are inflated in proportion to the loss of hydrogen. Although in the Parseval airship, these ballonets serve well for vertical steering, they do not perfectly accomplish their second purpose of keeping the balloon rigid, and the progressive substitution of air for hydrogen causes a decrease in buoyancy which must be compensated by dropping ballast. By the use of liquid hydrogen ballast it is possible to keep the buoyancy constant. Fig. 6 illustrates an experimental balloon, below which is a flask *F* filled with liquid hydrogen. Flasks of this kind, which almost entirely prevent the loss of heat by conduction or radiation, were first constructed by Weinhold and are known as Thermos bottles. The liquid hydrogen is evaporated by passing a current of electricity through a coil of wire in the interior of the flask.

If the buoyancy of the balloon has diminished, it is only necessary to evaporate a little of the hydrogen in this way. The operation is performed by connecting the copper wire *d* through a regulating resistance, with four or five storage batteries of an aggregate tension of eight or ten volts, and then gradually cutting out the extra resistance until the coil in the flask becomes hot enough to evaporate the hydrogen with the required rapidity. With all resistance out, the

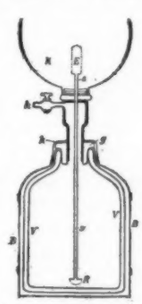


FIG. 3.—VERTICAL SECTION OF APPARATUS SHOWN IN FIG. 2.

flask of hydrogen is evaporated in less than an hour. The Weinhold flask contains 2 liters (4.4 pints) of liquid hydrogen and yields 53 cubic feet of hydrogen gas, possessing a lifting force of nearly 4 pounds. Furthermore, the evaporation is equivalent to a loss of 4 ounces of ballast. It is true that the buoyancy is diminished by the expulsion of a portion of the contents of the balloon, but this loss is diminished in proportion to the contamination of those contents with

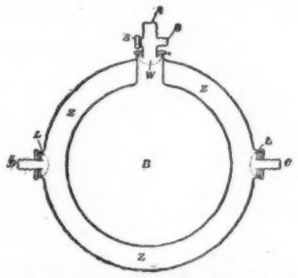


FIG. 4.—SECTION OF DOUBLE-WALLED GAS BAG FOR TRANSPORTING AND EVAPORATING LIQUID HYDROGEN.

air and to the lack of fullness of the balloon. In unfavorable conditions, i. e., with a freshly-filled balloon, the net increase of buoyancy produced by one flask of liquid hydrogen is a little more than two pounds; in favorable conditions, i. e., when the balloon has lost much gas, the increase of buoyancy may amount to four pounds.

The commutator of a dynamo or motor gives better results and wears less rapidly if it can be made to glaze over. As it is necessary in electro-plating dynamos to use copper brushes, it is more difficult to glaze the commutator than when carbon brushes are employed. Owing to the low conductivity of carbon, they would have to be made much larger than those of copper to carry the same current. The following composition has, according to the Brass World, been found excellent for glazing the commutators of electro-plating dynamos: Dissolve 4 oz. of caustic potash in 1 pint of water and then boil and add 1 oz. of flowers of sulphur. Boil until sulphur is wholly or partially dissolved, making a yellow-colored solution. Then add lard oil and boil until a soap is made. Cool and add a mixture of equal parts of flowers of sulphur and graphite—very fine, or that known as electrotypers' graphite—until a thick paste is produced. This is applied to the commutator, but very little is needed to produce the desired result.

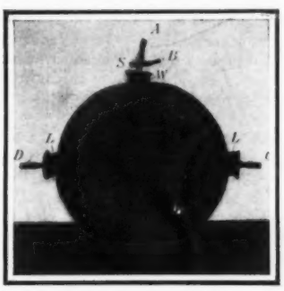


FIG. 5.—DOUBLE-WALLED GAS BAG FOR TRANSPORTING AND EVAPORATING LIQUID HYDROGEN.

INSTANTANEOUS X-RAY PHOTOGRAPHS.

A METHOD of making X-ray photographs of the interior of the human body, in a small fraction of a second, has recently been invented. This invention is of great medical importance. When we remember that the blood vessels and many other organs are set into vibration by the pulsations of the heart, it becomes evident that it has hitherto been impossible to obtain sharp X-ray photographs of the chest or even of the abdomen. In the heart itself the amplitude of this oscillation is about two fifths of an inch; in other organs the amplitude decreases in proportion to the distance from the heart. Dessauer has recently succeeded in obtaining good X-ray photographs with an exposure of one one-hundredth of a second. This was accomplished by energizing the Roentgen ray tube with an impulsive current of this duration. The device by

FIG. 6.—BALLOON WITH ATTACHED FLASK OF LIQUID HYDROGEN.

which the primary current of the induction coil is interrupted consists of a wire, of carefully calculated dimensions, covered with a thick coating of some hygroscopic material, such as plaster or clay, and inserted in the primary circuit. This wire is heated by the current to its fusing point. In this way water vapor is produced, the pressure of which very soon causes an explosion and breaks the wire. The self-induction spark is extinguished by the fine particles of dust arising from the explosion. By this method it is possible to photograph the separate phases of the movements of the heart.—Prometheus.

MINERAL OILS MIXED WITH CONCRETE.

SOME INTERESTING POSSIBILITIES.

BY ALBERT MOYER, ASSOC. AM. SOC. C.E.

THE mixing of oil (mineral) with concrete is very simple. The oil, alkalis and water will form an emulsion becoming thoroughly incorporated in the concrete. If the concrete is to be mixed by hand, proceed as usual and after the water has been added, the resulting mass turned and raked, add non-volatile mineral oil in proportion of 10 to 15 per cent of oil to the weight of the cement. Turn the concrete with shovels two or three times, raking while turning; the oil will quickly emulsify and become thoroughly mixed in the concrete.

If machine mixing is employed, use a batch mixer, turning a sufficient number of times to mix the cement thoroughly, sand, crushed stone or gravel, and water. Then add 10 to 15 per cent of non-volatile mineral oil. Turn again the same number of times as it requires to mix the concrete. The oil will quickly emulsify and become thoroughly incorporated in the concrete.

Oils added to concrete in proportions of from 5 to 15 per cent will slightly delay the initial and final set. Increasing proportions of oil will further retard both the initial and final set and hardening, but up to 15 per cent, from experiments so far made, it would seem that the retarding of hardening will not be sufficient to cause the work to be uneconomical.

The tensile strength will necessarily be reduced, and with the increasing percentages of oil toughness will be slightly diminished, but not in proportion to the increase in the percentage of oil used.

An extremely interesting paper was read at the meeting of the Association of American Portland Cement Manufacturers, at the Hotel Astor, New York, December 15th, 1909, by Logan Waller Page, Director Office of Public Roads, Agricultural Department, Washington, D. C., on the subject of the "Possibilities of Portland Cement as a Road Material," in which he described some investigations being carried on by Dr. Allerton S. Cushman in the Laboratory of the Office of Public Roads to ascertain the practicability of mixing semi-asphaltic base oils with Portland Cement concrete, with the object of obtaining the desirable properties of both Portland Cement and Asphaltum. So far only pats and briquettes have been made; the results obtained show ample strength for ordinary work, six-inch cubes will be tested later.

It is believed that compression tests will show greater strength than the usual relation of compression to tension. This is a matter for further investigation, and it is to be hoped that chemists and cement testers will actively take up this work and carry on investigations covering long-time periods.

Tensile strain tests should be discarded. Such tests have now been discarded by the German Portland Cement Manufacturers and compression tests substituted. With the increased scientific knowledge and the consequent better material produced by Portland Cement manufacturers, tensile strain tests have become obsolete, and owing to the brittleness and extreme sensitiveness of neat Portland cement, the unscientific methods employed in tensile strain tests, the personal equation involved, tensile strain tests do not indicate the possible load which Portland cement concrete may carry.

I would therefore earnestly advocate compression tests on cylinders of a size which will cause the area to equal 6-inch cubes. In order that such tests may be standardized and relative, standard sand should be used, and if possible a standardization of gravel or crushed stone. If crushed stone, trap rock should be used, all passing through a ¾-inch mesh and all collected on a ¼-inch mesh. Mix up cylinders which will theoretically figure maximum density, add varying proportions of oil from 5 to 20 per cent. Also make up another set of cylinders adding varying proportions of hydrated lime, from 10 to 30 per cent, increasing the percentage of oil with the increase of hydrated lime. The addition of hydrated lime theoretically should permit the addition of a larger percentage of oil, as we thus have a greater emulsifying material. Varying percentages of Portland cement may be used, always keeping the relation between the sand and stone the same, maximum density having been figured. The amount of Portland cement should be increased above that which is required to fill the voids in the sand.

Two months ago the writer made some briquettes and pats with the object in view of ascertaining if the mixture of oil with wet neat cement and mortar would have the tendency of keeping all but the excess water from leaving the wet, neat cement or mortar.

Briquettes were made, neat cement mixed with water, the water slightly in excess of that usually required, after which 10 per cent of oil petrol was added. (Oil petrol is a white, non-volatile petroleum product of about the consistency of melted vaseline.) Pats were made of 1 part cement, 3 parts sand mixed with water, a little in excess of what would ordinarily be used, after which 10 per cent of the same oil was added. These pats are about 2½ inches in diameter and ¼ inch thick.

As soon as made they were left in dry air, and the initial and final set was found to be normal. They were never immersed in water but remained in dry air for several weeks. No cracks occurred and they became so hard and strong that these pats, only one-quarter inch thick, were very difficult to break by the use of the fingers and thumbs. After remaining in dry air for three weeks, they were put out in freezing temperature for three days, and again placed in dry air over the radiator. No cracks or checks have occurred.

After remaining in dry air for a month, a test for absorption was made. A broken pat was weighed dry and found to weigh 94/64 ounce. It was then immersed in water for several hours. Upon removal from the water, the surface water was quickly removed with blotting paper, the pat immediately weighed and found to weigh 99/64 ounce. Only 5/64 ounce of water was absorbed.

The fact that the pats were never immersed in water and showed no evidence of checking or cracking, and became hard, would indicate that the emulsified oil had held the water in the mortar and that such mortar was, therefore, both non-evaporative and non-absorbent, which would tend to show that concrete in which mineral oil has been mixed would not be likely to contract and therefore contraction cracks avoided.

Under the theory of Prof. Bauschinger, which has been demonstrated by Prof. Swain in the Laboratory of the Institute of Technology, Boston, neat cement when set and hardened in air contracts and this contraction increases with age up to a certain period, possibly six months or a year. 1 part Portland cement, 3 parts sand hardened in air shows contraction, but less in proportion than neat cement. The results also prove that neat cement when hardened under water shows a slight expansion, while mortar composed of 1 part Portland cement, 3 parts sand, hardened under water, shows expansion, but less in proportion than the neat cement. Reducing these conclusions to figures and taking the average results obtained by various authorities, figuring the expansion and contraction by percentage the following are the results:

Neat Portland cement hardened in air at the end of 16 weeks shows 0.15 per cent contraction.

1 to 3 mortar hardened in air at the end of 16 weeks shows 0.05 per cent contraction.

Neat Portland cement hardened under water at the end of 16 weeks shows 0.05 per cent expansion.

1 to 3 mortar hardened under water at the end of 16 weeks shows a 0.015 per cent expansion.

(See "Hair Cracks," Albert Moyer, Engineering Record, December 16th, 1905.)

Mixing oil with concrete from the meager tests so far made, would seem to indicate that the oil held the water in the mortar, keeping the cement particles wet and thus furnishing the same conditions as if set under water, hence very materially assisting, if not altogether obviating contraction cracks and hair cracks or crazing. Furthermore, the resulting mortar appears to be far less brittle and therefore such treatment should admirably serve the purposes required of concrete retaining walls, foundations inclosing cellars, tanks, cisterns, etc.

Exhaustive tests have been made by a number of authorities on the action of oils on concrete. The effect of oil on concrete and the effect of oil emulsified in concrete are two separate and distinct subjects.

We are informed by reliable authorities that concrete immersed in animal or vegetable oils will in time disintegrate and that concrete immersed in mineral oils is unaffected. In the first instance there was no chance for the oil to emulsify, in the latter the oil is separated into minute globules. A large field of usefulness is ready for oil mixed and emulsified in concrete. The emulsion takes place after the oil is mixed with the wet concrete and not before as has been done in a patented article.

A mere casual glance at the uses of Portland cement concrete would indicate that oils mixed with the concrete would prove very desirable for dustless waterproof floors for office buildings, for slaughter-house non-absorbent floors, impervious concrete drain tile and sewers. If the experiments to be carried on in the future prove that mineral oils in the course of time are not disadvantageous, the drain tile problem has been solved, for there can be no action of the alkalis or other injurious elements to non-absorbent, dense, and impervious concrete.

Such concrete will be particularly desirable for silos. Some of the acids formed by the silage in the bottom of the silo would probably not attack a dense, non-absorbent, impervious concrete.

Contraction cracks will be eliminated in cisterns, drinking troughs, live stock feeding floors and platforms. Some objection may be raised to the use of oil-mixed concrete from the standpoint of its liability to flavor the water or the food. If we stop to consider that the oil is divided into minute globules, thoroughly emulsified, we will see that while there may be some odor there is not likely to be any taste after the drinking trough, feeding floor, or cistern has been in use for a few days.

Such oil-mixed concrete will be effective for liquid manure cisterns for the reason above described. It will also be particularly adapted to terrazzo floors, the great objection at present being due to contraction cracks. A white oil may be mixed with Portland cement, white sand, and water and used for the purpose of setting brick and stone; it being non-evaporative and non-absorbent no efflorescence or stains can occur. In fact such concrete can be used in any work not requiring extraordinary compression strength, and in which it does not come in contact with heat.

One of the particular advantages will be for stucco work, and exterior plasters.

It would seem that this idea of mixing oil with wet mortar is new, but like many discoveries it proves to be only a rediscovery. In the first century A. D., Marcus Vitruvius Pollio, the famous Roman architect, gives the following detailed specification for stucco: "A mixture of well hydrated lime, marble dust and white sand mixed with water, to which mixture is added either hog's lard, curdled milk, or blood."

In A. D. 1280 at Rockingham Castle, England, melted wax was mixed with the mortar.

In A. D. 1324 in the work of King Edward II, at Westminster, pitch was mixed with mortar.

The permanency of the Roman stuccos may be partially accounted for by the use of oil mixed with mortar. Although Vitruvius used hog's lard, an animal oil, the mortars have withstood the action of the centuries, and in places where freezing temperature occurs in winter and great heat in summer. However, the hog lard must have been very thoroughly emulsified by the action of the hydrated lime. Portland cement was unknown at that time.

In this connection, I would like to suggest the following specification for stucco, the third or finish coat:

1 part Portland cement, 20 per cent (volume of cement) of hydrated lime, 3 parts coarse white sand. First dry-mix the sand and cement and with this mix dry hydrated lime, turning each three times with shovels, rake while shoveling. Add water, turning and raking until the desired consistency is obtained. Then add 15 to 20 per cent of white oil petrol (Chesebrough Manufacturing Company of New York), the oil to be by weight in percentage to the weight of the cement. A gallon of oil petrol weighs 7½ pounds. Apply this mortar while the scratch coat is damp and as soon as the scratch coat is firm enough to stand the pressure or plastering. If it be desirable to tint the stucco, color the oil with any lime proof coloring matter, in proportion which by experiment with small samples is necessary to give the desired tint.

A white, non-volatile mineral oil is suggested for stucco and for mortar to be used in setting white marble or light-colored brick, on account of the color possibilities. For concrete where the color is not essential the heavy black bituminous oils to the light non-volatile petroleum oils are successful. They are cheap and their name is legion. Do not use oils containing organic matter and positively avoid, at least for the present and until further experiments have been made, vegetable or animal oils, as they are liable to form an acid which in turn may disintegrate the concrete.

Lime, sand and animal oils have stood the test of centuries. Portland cement and animal oils have not yet had this opportunity. It is within the range of possibility that the test of time may prove contrary to the theory, and animal oils emulsified be found not dangerous, we will then consider a remark made by a very noted chemist: "If theory conflicts with the fact, we will have to change the fact."

SERUM THERAPY.

HOW SERUMS ARE EMPLOYED IN MODERN MEDICINE.

BY DR. FRITZ MEYER.

SERUM therapy is the treatment of disease by injecting into the blood the serum, or watery part, of the blood of an animal that has been made immune to that disease. Something similar to serum therapy appears to have been practised in antiquity. Mithridates, king of Pontus, fearing that he would be poisoned, caused repeated small doses of various poisons to be administered, for long periods, to ducks, the blood of which he drank, with the astonishing presentiment that it must contain effective antidotes to the poisons. The members of an ancient priestly caste in India allowed themselves to be bitten frequently by snakes which had been deprived of their poison glands. These priests claimed that their saliva thus acquired power to save the lives of persons who had been bitten by venomous serpents. These methods of treatment undoubtedly originated in the mind of some man of genius and were afterward practised ignorantly and according to tradition. Many centuries later a very important science was founded on the same basis.

In 1888 the French physiologists Richet and Héricourt, inspired by Pasteur's theory of vaccination, made the surprising discovery that rabbits survived injections of ordinarily deadly doses of certain bacteria if they had recently received injections of the blood of dogs which had been treated with increasing doses of the same bacteria until they had become immune to the action of doses normally fatal to dogs. In other words, Richet and Héricourt discovered the possibility of communicating to another animal the immunity which Pasteur had succeeded in producing in the individual by repeated and increasing doses of the disease germ.

Two years later Behring expressed the conviction that acquired immunity is due to the presence of definite protective substances in the blood, and that this condition can be transferred to other individuals by injections of serum.

Diseases of three classes are caused by bacteria. In the first class, represented by diphtheria, dysentery and tetanus, the bacteria settle in one part of the body, where they multiply and produce poisonous substances, or toxins. The toxins enter the circulation of the blood, but the bacteria do not. In the second class, represented by erysipelas, puerperal fever, pneumonia, meningitis and diseases resulting from the infection of wounds, the bacteria enter the circulation of the blood and invade every part of the body. Diseases of this class are called septic diseases and are very often fatal. In none of them has any true toxin, or soluble poison, been discovered. In the third class, represented by typhoid fever, cholera and plague, both the bacteria and their toxins enter the general circulation.

Tuberculosis, the disease which causes more deaths than any other, has not yet been satisfactorily classified or explained. Although countless autopsies and other investigations are continually being made, we do not know whether Koch's bacillus kills by producing toxins or directly by its multiplication in the blood and tissues of the body. As the forms of disease caused by bacteria differ, so must the protective or immunizing influences which their germs develop in the blood. Ehrlich and Behring distinguish three classes of protective serums: serums containing antitoxins, or substances which neutralize the toxins of diseases of the first class; anti-bacterial serums, which check the multiplication of bacteria, in diseases of the second class; and serums which combine both of these properties and are efficacious in diseases of the third class. Hence, in view of our ignorance of the precise character of tuberculosis, it is not surprising that no efficient serum for that disease has yet been produced.

In France, Austria and some other countries, therapeutic serums are prepared in government establishments, called Pasteur institutes. In Germany, a few great chemical firms have taken up the work. The serum is obtained from the blood of horses. The weight of the animal having been determined, a minimum dose of a toxin or a bacterial culture is injected, according as the object is to produce an antitoxin serum or an antibacterial serum. The horse reacts to the injection with slight fever and other symptoms of ill health. After these have passed and the initial weight has been regained a second dose, twice as large as the first, is injected. In this way the injections are repeated and increased for a few months, until the horse finally fails to react to a dose large enough to kill 1,000 unprepared horses. Three weeks after this condition of immunity has been attained about two gallons of blood are drawn from the horse's veins. After the blood has coagulated, the clear serum is separated from the clot and its curative power is tested by injecting it into the circulation of mice, guinea pigs, monkeys and other small animals, which have previously received injections of the toxin or the bacterial culture of the disease in question. This examination in the factory is followed by rigid official tests applied at the Ehrlich Institute in Frankfort. The serum cannot be sold for use on human beings until its potency has been officially determined and stamped upon the bottles. In the case of diphtheria serum, the only one for which the system of gradation adopted can be regarded as final, the unit is a quantity of antitoxin sufficient to protect a guinea pig against 100 times the normally deadly dose of the toxin of diphtheria. A serum which contains one unit of antitoxin in each cubic centimeter, is called a normal serum and its potency is 1. A serum 1,000 times as strong is of potency 1,000, and so on.

The most successful results have been obtained with antitoxin serums, especially in diphtheria, tetanus and dysentery. In all of these diseases the serum exerts a curative action and abates the distressing symptoms. The statistics of diphtheria clearly demonstrate the importance of Behring's discovery. Only sixteen years ago the diagnosis "diphtheria" created panic in the family of the patient. Tracheotomy was frequently practised and many children died of suffocation. Now, if the serum is administered promptly at the outbreak of the disease, the suffering child becomes quiet, the temperature falls and the pulse regains strength in eight or ten hours. The morbid accumulation is expelled from the throat, sleep becomes possible and 36 hours later the child is convalescent. The result which nature can accomplish only in weeks, by slowly producing antitoxin in the body of the patient, modern science effects in a few hours, by administering antitoxin which has been formed in the blood of horses.

The antibacterial serums, which are employed to check the propagation of living germs and their dissemination through the body, work in far less favorable conditions, for every one of the host of microbes already produced is a fresh source of infection and even those which have been killed by the serum may cause serious organic injury. Hence these serums are efficacious chiefly, or only, when they are administered while the bacteria are still at the point of entrance and before they have become disseminated through the body. This is especially true in infected wounds, puerperal fever, pneumonia and splenic fever. For all of these diseases we possess serums which prevent the dissemination of the germs and protect the organism from fresh infection, but it is seldom possible to cure a patient whose blood is already poisoned by the disease germs.

In diseases of the third class, which includes typhoid fever, cholera, and plague, the serum is required both to neutralize toxins and to check the multiplication of bacteria. The serum therapy of these diseases is still in its infancy, but experience has convinced me that success will ultimately be attained.

In tuberculosis the prospect is less bright. No effective immunizing agent is yet known. A serum prepared by Marmoreck has recently attracted much attention, but its curative value must still be regarded as doubtful.

The statistics of diphtheria, on the other hand, show that the mortality in this disease has been reduced, by the introduction of the serum treatment, from between 30 and 41 per cent to 16 per cent, and to between 2 and 6 per cent of the cases in which the serum is employed in the first two days of illness. In an epidemic of diphtheria in Berlin in 1895 the mortality was 32 per cent in a hospital in which the serum was not used, and only 8 per cent in a hospital in which it was used. Behring was fully justified in asserting that the serum treatment of diphtheria annually saves 20,000 human lives, in Germany alone.

In every disease to which serum therapy is applicable, the benefit derived from the treatment increases with the promptness of its application. The rule should be, not to wait until the disease has appeared, but to begin the serum treatment at the first sign of danger. Hence diphtheria serum is administered to all the children of a family in which a case of diphtheria occurs, tetanus serum is administered when a wound has been contaminated with earth (for the germ of tetanus lurks in the soil), and puerperal fever is prevented by injecting streptococcus serum at the first appearance of fever in childbed.

This employment of serums is destined to revolutionize all therapeutics. The more fully convinced of its harmlessness physicians become, the more will they be inclined to employ it, even at the risk of taking an unnecessary precaution. The excellence of the results obtained by this early employment of serums is due to the fact that all the toxins or bacteria that subsequently invade the body are attacked and destroyed immediately upon their entrance, before they can reach important organs.

In contrast to this preventive serum treatment is the curative treatment, employed after the disease has actually appeared. In the latter case the objects of the treatment are to check the multiplication of the bacteria and their production of toxins, and to free the cells of the body from the toxins which have already become attached to them. It is not certain that the second object can be accomplished. There is good reason to believe that a cell, once poisoned, is incurable and doomed to death. But if the general organism is freed from poison, it easily survives the loss of a few cells, and replaces them by new ones. If the injury is extensive a scar is formed by the substitution of useless connective tissue for active cells, but if the disease is quickly checked and the general vitality little impaired no permanent lesion is produced. Hence the action of serums is essentially preventive, even when it appears to be curative, for it is the protection of the tissues which have not yet been attacked that assures the replacement of the parts which have been destroyed.

The principal reason why the employment of serum treatment is so often delayed is to be found in the attitude of the public. The physician is often induced, by the violent opposition of the family, to wait until the favorable moment has passed. Many cases of diphtheria and puerperal fever are lost in this way. Furthermore, the older physicians are not very familiar with the theory and practice of the method and are not inclined to employ it except in desperate cases. But these obstacles are gradually being removed as the increasing success of the continually improved serums gains new advocates of serum treatment.

The popular opposition to the new method finds some apparent justification in the unpleasant effects which it often produces. In about one case in five, the injection of serum is followed, in a week or so, by eruption and itching of the skin, slight fever and pains in the joints. These symptoms are justly attributed to the injection of serum, but recent experiments prove that they are caused, not by the antitoxin, but by the action which certain substances, formed in the human organism under the influence of the serum, exert upon the albuminous constituents of the equine serum. The eruption is harmless and no patient has lost his life because of it.

Which diseases appear most likely to find effective serum treatment within a reasonable time? Unquestionably diphtheria and dysentery, in both of which a very gratifying degree of success have already been attained. Although tetanus is a disease of the same class, the toxin class, serum treatment of tetanus has met with little success. An effective method cannot be developed until improved methods of diagnosis enable us to detect the disease before the beginning of the convulsions. So long as tetanus can be diagnosed with certainty only from the convulsions the majority of patients will die, though treated with the best of serums.

In the second, or septic, class of diseases, the situation is very similar. With the same serum, results a hundredfold better are obtained by a good diagnostician than by a poor one, and success in treatment must wait for improvement in diagnosis. A new field, however, has been opened for the employment of antibacterial serums in these diseases—the field of local application. Recent investigations encourage the hope that peritonitis and meningitis can be checked in their first stages and quickly cured by the influence exerted upon the white corpuscles of the blood by antibacterial serums applied at the point of initial infection.

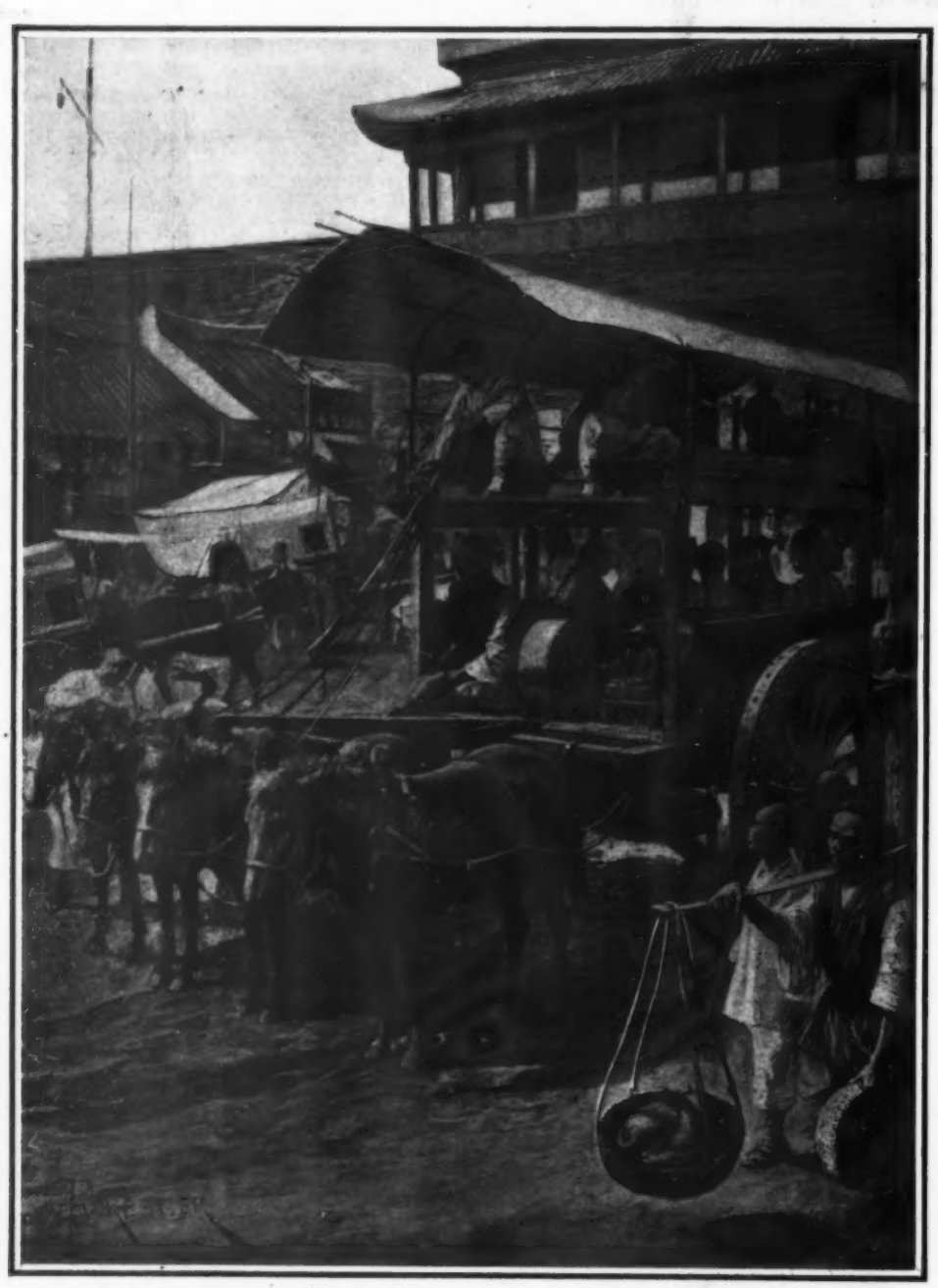
There is also good reason to hope that more efficient serums than those now known will soon be obtained, by a double immunizing process, for the diseases of the third class, typhoid, cholera and plague.

In tuberculosis, however, there is no immediate prospect of finding a method in any way superior to the rational and natural treatment with fresh air, sunlight and abundant food. We must continue our studies until we learn more of the nature of the specific poison and the germ which produces it.—Umschau.

AN OLD-TIME "TAXI-CAB."

A CHINESE ANTICIPATION OF A MODERN INVENTION.

THE taximeter cab, or "taxi-cab" as it is called in New York, is quite the latest thing in the streets of our modern cities. And yet the old adage "there is nothing new under the sun," is peculiarly applicable to what we are all inclined to imagine is the product of the twentieth-century brain. An Oriental contemporary (Ostasiatische Lloyd) states that the Chinese can prove, from one of their old richly illustrated historical works, that already in the eleventh century they had invented and were using a "giligulicha" (or "counting mile drum car") which possessed many of the features of the modern taxicab. Judging from the several illustrations of the "giligulicha," contained in the famous "Tsan-thu-hae" collection of pictures, the vehicle had one single pole or shaft, ran on two wheels, and consisted of two stories. In each of these compartments or divisions there was a wooden figure holding a mallet in the right hand; these mallets were arranged to strike upon a drum in the lower story, and upon a gong in the upper one. When the vehicle had traversed a certain predetermined distance, the lower figure struck the drum with its mallet, whereupon a cog-wheel made a revolution. When a distance of ten miles had been covered the upper figure struck the gong with its mallet. In some cases this Chinese taximeter car was also fitted with a compass which, owing to the total lack of landmarks and signposts, was of great value to the Celestial "chauffeur" of that time. A magnet was also provided; it was located in a small box, and influenced a block upon which there was fastened a small jade or wooden figure the outstretched arm of which always pointed due south.



By courtesy of Illustrated London News.

Attention was called to the ancient measure-mile-drum-carriage of the Chinese in a lecture given by Professor Giles, of Cambridge, some time ago. The Professor found a reference to the "taxi-cab" in the History of the Chin Dynasty (A.D. 265-419). In the years A.D. 815, 820, and 987, further mentions were made of such a "taxi-cab," and there was a description of the vehicle, a portion of which we give. "At the completion of every *li*, the wooden figure of a man in the lower story strikes a drum, and at the completion of every ten *li* a man in the upper story strikes a bell." The length of the Chinese *li* is variously estimated. Some say that it was 479 yards; others that it was 699 yards. It is supposed to have represented one-tenth of an hour's march.

THE LI-MEASURING CARRIAGE OF OLD CHINA: THE "TAXICAB" OF 265 A. D.

LUMINOUS PHOTOGRAPHS.

IT is not difficult even for a non-professional photographer to make prints of his pictures having the peculiarity of a phosphorescent luminosity. The process is somewhat circumstantial, but with reasonable skill should not present many difficulties. The luminous substance employed is the white sulphide of calcium, that glows in the dark if previously exposed to the light. As the substance is rapidly transformed into the bichromate of potash, the period of handling must be curtailed as much as possible. According to a suggestion in the Photorevue, a solution of 30 parts of gelatine, with ten times the volume by weight, of water, is made moderately warm and three parts of bichromate of potash and 12 parts of phosphorescent sulphide of calcium stirred in. With this mass, a piece of common celluloid film is coated, the coating allowed to dry, and it is then exposed in a printing frame under the positive to the light, the non-coated side of the celluloid being in contact with the positive. The duration of exposure should be about the same as for a carbon print and the development is likewise effected with the aid of warm water.

EXCAVATIONS AT CORBRIDGE.

INTERESTING results have been reached in the excavations at Corbridge, the Roman Corstopitum, which have been going on since 1906, and were described in a lecture to the members of the Carlisle Scientific and Literary Society by Mr. R. H. Foster, M.A. The site of the excavations is to the west of Corbridge, on the north bank of the Tyne at a point where a Roman bridge carried Dere or Watling Street across the river. Unlike many Roman cities now overlain by modern towns, Corstopitum is situate in open fields, and by the aid of the foundations which have been uncovered an idea of the plan of the place, the direction of the streets and the character of the buildings has been disclosed. They incline to the arrangements common to a civil community combined with features more definitely military. In 1907 a large and important building, probably a private residence, which had been many times altered and extended, was discovered on the rising ground to the northeast of the bridge. In its latest stage it comprised a series of eight apartments arranged between two corridors, and returned at both ends towards the south. The south corridor was warmed by a pillared hypocaust below the floor, divided midway in its length by a door, the threshold of which is still *in situ*. Hypocausts of larger size but rougher construction were found under two of the rooms at the west end of the building, and one of the eastern rooms was warmed by a series of boxed wall tiles. The wall plaster on some of the rooms had been repeatedly decorated in colors. On the south front of the house there was a cobbled terrace overlooking the river below, and on the north an enclosed courtyard, paved with cobbles, and containing an ornamental cistern, in which was found a fine piece of sculpture of a lion and a stag. On the plateau to the north, and possibly in the central district of the city, massive and important buildings were encountered. These bordered on a street about 36 feet in width of three different levels, with corresponding drains and gutter stones. The buildings comprised a store in which, under a mass of burnt stuff, was discovered a quantity of pottery, strewn, as it had fallen from the shelves, in separate heaps. The discoveries of 1908 were most important and interesting. Operations were commenced on the wide east to west street through the town. They revealed on the north side four structures, two of them strong buttressed barns or granaries at right angles to the street, and almost 100 feet in length; the fountain and a portion of a massive building comprising a number of chambers arranged about a quadrangle, the west range of which is 221 feet in length, and had for convenience been called the "Forum." Of the noteworthy finds, the most remarkable was that of a hoard of gold coins, forty-eight in number, inclosed, together with a gold ring, in a piece of lead, and secreted 18 inches below the present ground level in a building of late date. The coins included examples of the reigns of Valentinian I., Valens, Gratian, Valentinian II., Theodosius and Magnus Maximus, and ranged between the inclusive dates of 370-85. The coins were all in an excellent state of preservation, and with the exception of a find at Cleeve, near Cheltenham, in 1811, constituted the largest find of Roman gold coins made in Britain. The excavations of last year also produced a remarkable quantity of fragments of pottery, Samian ware being very abundant. Other kinds of pottery were also plentiful, ranging from Castor ware to rude black hand-made pottery. The work done during the past season (1909) has been more important, if in some respects less striking, than in 1908. Further explorations in front of the granaries has revealed the fact that the southern or street face of each had had a portico of four massive pillars. In the case of the east granary, this portico was probably of the same date as the main building, viz., about A. D. 140. The other portico was of later date, and was probably added in the time of Severus to a building which possibly dated as far back as A. D. 120.

In a recent report of the Illinois State Highway Commission it is recommended, says Ferro-Concrete, after careful study and actual experience throughout the State, that all highway bridges on 50-foot span and under shall be constructed in ferro-concrete on the ground that this is "the most permanent form of construction known to engineers to-day." The report proposes that all highway bridges up to the span mentioned should be replaced within the next two years by ferro-concrete structures.

MINIATURE ART OF NATURE AND SCIENCE.

THE BEAUTY REVEALED BY THE MICROSCOPE.

BY DR. V. GRAFE.

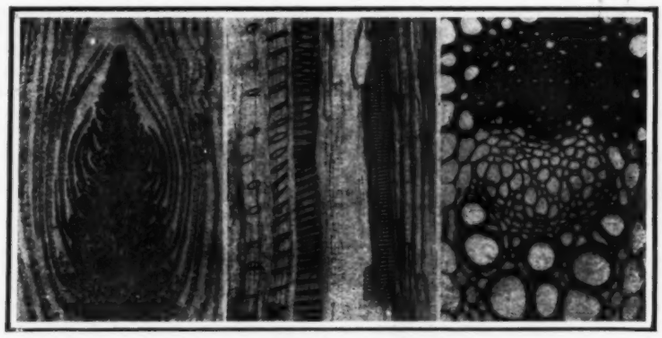
THE improvements of the microscope of Leewwenhoek opened to our view a world of miniature marvels, and the subsequent development of the instrument and of the methods of microscopic research enable us now to recognize exceedingly fine and remarkable details in the anatomical structure of animals and plants, and thus to gain an insight into the processes of life. Many anatomical preparations are masterpieces of technical art and skill, showing all details which are resolvable by the microscope and, which, in many cases, are present only in particular stages of the development of the organism. Every living cell is a microcosm in which an infinity of events is transpiring. In the first place, there is the living protoplasm, with its mysterious structure, then the nucleus, which plays so important a part in reproduction and heredity and which possesses the power to subdivide itself according to regular laws, after it has transformed itself into a structure of amazing complexity. All these wonders of life are laid bare by the knife of the expert anatomist and are made more conspicuous by the application of various dyestuffs, each of which stains only certain parts of the cell. Hematoxylin, for example, colors only the nucleus and thus brings it into prominence. The phenomena of the division of the nucleus are made distinctly visible by a triple staining with safranin, gentian violet and orange yellow. With the instrument known as the microtone it is possible to make a long series of successive thin sections of an object, which has previously been saturated with paraffin by a complicated process. The preparation is imbedded in Canada balsam to protect it from external influences.

Microscopic preparations are absolutely necessary for the study of natural history, and it is also necessary to give the student opportunity to examine them very thoroughly, for the unpractised eye often fails to observe important details, at the first glance, unless attention is especially called to them. For this reason it has long been customary to make drawings, which can be studied at leisure, of objects as seen with the microscope. But this method is open to serious objection. Although great improvements have been made in the method of making such drawings, it is still impossible to reproduce every detail of the microscopic picture. Furthermore, every such drawing is affected by the personal error of the draftsman, for no two observers see the same object alike. During the last ten years attempts have been made to solve the problem with the aid of photography.

Until recently only special students of natural history have experienced any great need of microscopic objects or representations of them, but with the increasing popularity of the natural sciences this need is becoming felt by the schools and the general public. Artists, also, find here an inexhaustible source of inspiration, as Haeckel and Boelsche have pointed out. It is only necessary to glance at the drawings of Hinterberg, the first eminent artist to enter this field, or to examine some of the botanical and zoological objects themselves, in order to appreciate the interesting problems which are here presented to the draftsman, the sculptor, and the goldsmith. Many microphotographs of these objects contain ideal designs for carpets, wall paper, jewelry, and embroidery.

The making of such photographs is not easy. The sections, which are always difficult to make in the case of embryos, leaf buds and numerous other objects, must for this purpose be executed with especial care, in order to give prominence to the particular detail which it is desired to reproduce. The staining requires special knowledge and skill, which differ with almost every preparation. Not the smallest hair or grain of dust must be permitted to mar the distinctness of the picture. In photographing, the microscope is placed horizontally and in exact alignment with the bellows camera and the source of light—self-regulating arc lamp. The degree of enlargement must be chosen with careful reference to the sharpness of the picture. The time of exposure depends on the thickness and transparency of the object. It is also necessary to employ taste and discrimination in the choice of objects for, while the draftsman can correct nature here and there, the camera reproduces every defect with ruthless accuracy. The photographic operations require good scientific training as well as technical skill, in order that the anatomical and photographic details may harmonize. From the negative are made positive lantern slides which can be projected on screens to exhibit all the microscopic details to large numbers of spectators.

The photographs here reproduced were made in Hinterberg's laboratory from objects prepared by Dr. Jencic of the University of Vienna. One of the pictures (Fig. 5) shows a cross-section of a linden stem. In the center and occupying most of the section is the vascular tissue of woody cells of large diameter, which is called the xylem and serves for the transport of water. Surrounding this is the thin cambium layer in which the growth of the stem in thickness takes place. Next comes another vascular layer, the phloem, in which flow the currents of elaborated sap, and on the outside is a layer of long and thick bast cells, which give flexibility and toughness to the stem. The water conduits of the xylem are formed by the coalescence of cells in the young roots, stem, branches and leaves into long tubes, the walls of which are stiffened by many rings, spiral and interlacing ridges, and



Left-hand picture—Terminal bud. Middle picture—Longitudinal section of stem, showing water tubes of various forms. Right-hand picture—Cross-section of a vascular bundle (more highly magnified). The thick-walled dark cells at the top are bast cells, the thin-walled cells below them are phloem, and the large circles at the bottom are water tubes.

FIG. 1.—THREE MICROPHOTOGRAPHS OF THE WATER WEED (ELODEA CANADENSIS.)

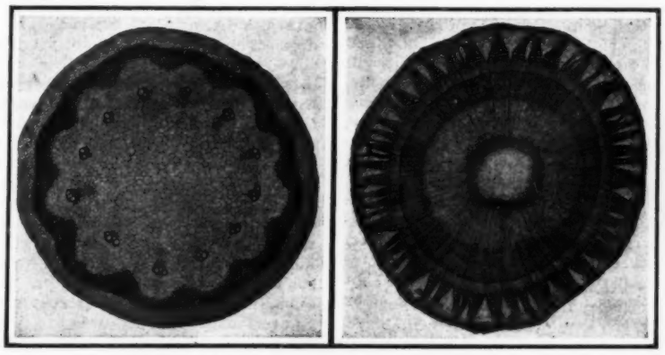


FIG. 4.—CROSS-SECTION OF EXOGENOUS ARISTOLOCHIA.

Showing vascular bundles arranged in a circle.

FIG. 5.—CROSS-SECTION OF THREE YEAR OLD STEM OF LINDEN.

Showing three annular rings and an encircling ring of bark.

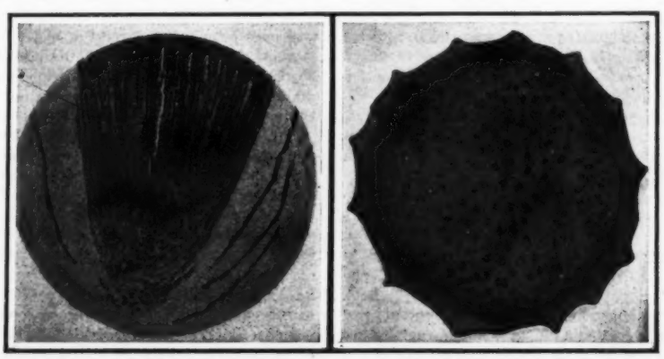


FIG. 2.—THE TIPS OF A ROOT.

FIG. 3.—CROSS-SECTION OF ENDOGENOUS DRAGON TREE.

Showing vascular bundles distributed irregularly.

FIG. 6.—ERGOT.

which extend from the roots to the leaves.

The vessels of the phloem which serve for the conveyance of elaborated sap are of very different construction. They are called sieve tubes and are formed by the partial coalescence of cells, the transverse walls of which have not, like those of the component cells of the water tubes, nearly or quite vanished, but have merely become perforated like sieves. The sieve-tubes begin in the leaf where, together with the water tubes, they form the so-called "veins," and, like the water tubes, they continue down through the leaf stalk, twig, branch and stem or trunk, to the root. The sieve-tubes and water-tubes constitute the vascular bundles. The coarse water-tubes are nearer the axis, the fine sieve-tubes nearer the bark. The two great classes of flowering plants, endogens or monocotyledons and exogens or dicotyledons, are distinguished from each other by the structure and arrangement of the vascular bundles. In endogens, which include palms, lilies, etc., the vascular bundles are very numerous and are distributed irregularly through the entire cross-section of the stem, though more closely near the circumference (Fig. 3). New bundles appear among the old ones as the stem increases in size. In exogens (Fig. 4), which include our common timber trees and many other plants, the vascular bundles are arranged in a circle which increases in size with the stem. Between the sieve-tubes and the water-tubes is a ring of soft cells, the cambium, which continually increase in number by cell-division during the growing season, from April to September, and thus cause the stem to increase in girth. The cambium layer surrounds the wood and is surrounded by the thin bast layer, which lies immediately beneath the bark. The wood of our common forest trees, when sawn crosswise, shows a number of concentric rings from which the age of the tree can be determined, for each ring represents the result of the activity of the cambium during one annual period of growth. The new wood formed in spring contains more numerous and larger tubes than the wood formed in autumn. The wood of spring is deposited next to the wood of the preceding autumn, and the sharp contrast between them produces the conspicuous annual ring. Most tropical woods, being endogenous, show no annual rings, and are thus easily distinguished from native woods.

The contrast in the manner of growth of aerial and underground parts of the plant is also instructively shown by microphotographs. The terminal bud is composed of a number of leaves and scales of which the older and harder inclose and protect the younger and softer. This formation is especially well marked in the water weed (*Elodea Canadensis*, Fig. 1). The rootlets, on the contrary, grow directly from the interior of the root. The tip of every root is protected by a cap of harder cells and contains starch grains, the weight of which, according to Haberlandt, causes the root to grow downward. These starch grains are organs of equilibrium, like the otoliths, or grains of carbonate of lime, in the ears of higher animals.

Another interesting photograph (Fig. 6) shows a section of the pileus, or reproductive part, of ergot or "smut," a poisonous fungus which grows on the grain of rye and has caused many deaths. The bottle-shaped glands are filled with the black spores which give "smutty" rye its characteristic appearance.

These few examples may serve to give some idea of the wonders which are revealed by the microscope and which it is now possible to exhibit to great numbers of spectators with the aid of photography and the projecting lantern.—Translated for SCIENTIFIC AMERICAN SUPPLEMENT from Reclam's Universum.

HALLEY'S COMET.

SUGGESTED OBSERVATIONS.

THE Astronomical and Astrophysical Society of America, through its comet committee, is soliciting cooperation in the observation of Halley's comet at the present return, and has prepared a circular letter of advice that has been widely distributed among observatories with regard to such observations. A copy of this circular will be sent to any astronomer who may desire to use it, upon request being made to the chairman of the committee, Prof. G. C. Comstock, Washburn Observatory, Madison, Wisconsin. As many astronomers and other observers of Halley's comet will be interested in the suggestion made by the committee, the circular is here reprinted in a slightly abridged form.

It is desirable that the position of the comet be well observed during the entire period of its visibility, and it seems probable that extra-meridian observations will be secured in sufficient number with especial solicitation. In view, however, of possible large perturbations arising from the close approach of the comet to Venus on May 1, and to the earth on May 18, meridian observations are especially desired during the period in which the comet is sufficiently bright for that purpose. An examination of the amount and character of these comet perturbations and their adaptability to a determination of the mass of the planets producing them has been undertaken by Profs. Leuschner and Crawford, and in case the conditions prove favorable, the meridian determinations may well be supplemented by heliometer observations of the positions of the inner planets with the view of a possible determination of the mass of the comet itself.

The close approach of the comet to the earth promises unusual opportunity for a study of the physical conditions that obtain in such a body, and, as an indispensable basis for such study, the committee recommends a photographic campaign as long and as nearly continuous as possible. The comet's close proximity to the sun's direction at the time of maximum brilliance imposes serious limitations upon this programme, and widely extended co-operation will be required throughout the whole circuit of the earth if this ideal of a continuous photographic record is to be even remotely realized.

About one-third of the earth's circumference in longitude is covered by the Pacific Ocean, within which there is known to exist no observatory with proper facilities for celestial photography. To fill this gap, at least partially, the committee, aided by a grant from the National Academy of Sciences, proposes to send to the Hawaiian Islands an expedition to photograph the comet during the period of its greatest brilliance.

The ends to be served by these photographs, and others obtained elsewhere, are as follows:

To give a permanent record, as continuous as possible, of the phenomena and changes (1) in the tail of the comet, with special reference to outgoing masses; (2) in the head and nucleus of the comet, particularly as to the formation of envelopes and jets.

The following suggestions as to procedure and precaution in making the photographs have been formulated by Prof. Barnard.

PHOTOGRAPHY OF COMETS.

One of the greatest difficulties in photographing the average bright comet is its proximity to the horizon, and consequent projection on a more or less dawn or twilight sky. The effect of this illuminated background with any considerable exposure is to fog the plate to such an extent as either to ruin it or to prevent a proper development of the image of the comet. A difference of three or four minutes in the duration of exposure when the sky is brightest may make a success or a failure of the picture. It is impossible to establish fixed rules as to when the exposure should stop or begin; so much will depend upon the condition of the sky, the position of the comet, the kind of lens, the rapidity of the plates, etc. The best rule is that of the judgment of the observer at the time, and this can only be derived from actual experience in the work.

The plates should be backed with the following to prevent halation: Cook two pounds of white sugar in a saucepan without water until nearly in the caramel stage, then add one pound of burnt sienna. Cook a little more (but not to the candy stage), stirring well. Finally, add about one-half an ounce of alcohol to each pint of backing as a dryer. This backing will keep indefinitely. When it is too hard, moisten it with a little water. This is to be applied to the back of the plate as a stiff paste with a broad camel's-hair brush, and should be applied just before using. A piece of old newspaper pressed upon this will prevent its being rubbed. The face of the plate should be very carefully dusted with a broad camel's-hair brush after it has been placed in the plate holder. The camera tube should also be frequently wiped out with a damp cloth to avoid dust. Before developing, remove the backing with moist absorbent cotton. If a little remains on the plate it will not injure the developer. In removing the backing be careful to shield the plate from the dark-room light. Do not wet the surface of the plate before pouring on the developer, as it may cause air bubbles on the film; swab it carefully with absorbent cotton at the beginning of development. Develop until the plate is almost opaque to the ordinary developing light. Fix for twenty minutes or more in the ordinary fixing bath (frequently made new), to which has been added a teaspoonful of sodium bisulphite to prevent discoloration.

Lumière Sigma dry plates are recommended, because of their rapidity. Seed 27 Gilt Edge and Cramer Crown are both beautiful plates, but are not now so rapid as the Sigma.

Hydrochinon developer gives a good strong negative, and for astronomical work is excellent. Rodinal in a weakened form, say 1/60 or 1/70 of water, with a longer development, will give a soft and more transparent negative, especially suited for showing the details of the head of the comet on large-scale photographs.

The doublet, or portrait lens, such as is made in America by the Brashear Optical Company and the Alvan Clark Corporation, on account of its wide field, is the best form of instrument for showing the general features of the comet and its tail, and especially for following any outgoing masses that may appear in the tail. One of about 6 inches (15 centimeters) aperture will be the most generally used, because of the expense of such instruments. It should be supplemented by several smaller lenses. A "lantern" lens of 1 3/5 inches (4 centimeters) aperture and about 6 inches (15 centimeters) focus, made by McAllister, of New York, is recommended for showing the extent of the tail. The cost of one of these lantern lenses is seven dollars. It gives a good field of twenty to thirty degrees, especially when diaphragmed down to 1 inch. It is extremely quick for comet work. Its focus should be carefully determined by star trails.

In comet work it is important in all these lenses that the camera should be so adjusted on the mounting with respect to the guiding telescope that the head of the comet can be displaced to one side of the field to secure a greater extension of the tail. Two of the small lenses may be so arranged by a mutual adjustment as to cover the full length of the tail, even though it should be fifty degrees long or more. Although it would thus be in two sections—the head and part of the tail on one plate, and the rest of the tail on the other—there would be no serious objection if the whole tail could thus be secured. The large reflectors will be of the utmost importance in dealing with the detail and structure of the head and envelopes, as has been recently shown at Greenwich.

Until something further is known of the spectrum of the comet, it would be unwise to attempt to give any specific directions as to the duration of exposure required with any telescope. Daniel's comet of 1907, and Morehouse's of 1908, were very different in respect to their photographic activity. The latter was relatively many times more actinic in its light, and hence required much shorter exposures to show the same strength of tail. This information must come from actual experience with the comet. It would seem, however, that the circumstances of the comet's visibility when brightest will make short exposures necessary.

The committee will be pleased to receive from every astronomer who may co-operate in the matter copies (glass positives) of his negatives of Halley's comet, and it will undertake the comparison and discussion of the material thus collected.

SPECTROSCOPIC OBSERVATIONS.

For spectroscopic observations of the comet the committee makes the following suggestions, formulated by Prof. Frost. While it may be possible to make visual observations of the comet's spectrum with ocular spectroscopes attached to large telescopes, it is likely that most of the photographic records of the spectrum will be obtained by the objective prism or the slit spectrograph, and reference will be made in what follows to the use of these two types of instrument.

These methods of observation are mutually complementary; for the accurate measurement of wave-length, effect of motion in the line of sight, and analysis of structure of lines or bands (if sufficiently sharp), the slit spectrograph has all the advantages, but for study of distribution of elements in different parts of the comet, and for reaching faint details, the prismatic camera, or objective prism, with its much greater light-power, is essential. The prismatic camera may be employed, with a fair possibility of success, when the comet's brightness is equivalent to that of a ninth or tenth magnitude star; the slit spectrograph cannot be hopefully applied before the comet is two or three magnitudes brighter. The size and kind of telescope employed, of course, make such statements relative rather than absolute, and uncertain at best. Too much here depends upon the comet; if its light is chiefly reflected rather than intrinsic, and the continuous spectrum is predominant, then the comet will have to be much brighter for satisfactory spectroscopic analysis than if the light is largely intrinsic and

concentrated at half a dozen points in the spectrum. Comets showing sudden and marked fluctuation in size or brightness are likely to exhibit changes in the bright band spectrum.

(1) Prismatic camera or objective prism.

The camera should be a doublet of large annular aperture, 1/4 or 1/5. Useful observations could be secured if the linear aperature is as small as 4 or 5 inches (10 or 12.7 centimeters). The objective prism should be of small angle, perhaps 10 deg. or 15 deg.; if an additional prism is available for the period of the comet's greatest brightness, its angle should be about three times that of the smaller prism. If the doublet is of comparatively short focus, as is likely to be the case, it will be found to be quite sensitive to focus, and separate exposures will be needed for the blue-violet region and the yellow-green region. Optical parts transparent to ultra-violet would be useful, as there may be some important bands of shorter wavelength than λ 3883.

It is very desirable to photograph the spectrum of a star before or after the comet, placing the star at such a point on the reticle of the guiding telescope that the stellar lines may serve for comparison.

Prof. Pickering suggests that an interesting observation would be to photograph the spectrum of a star when seen through the bright portion of the tail, to see if dark absorption lines could be detected.

(2) Slit spectrograph.

A small spectrograph will be a very useful attachment to a photographic doublet as described above. It need not be complicated, and its dispersion may be small. Apparatus for producing a comparison spectrum is not essential, for a neighboring star of the first type may be brought upon the slit, and its spectrum impressed above and below that of the comet. With one thread of the guiding telescope, or finder, movable, the star can be placed so that its spectrum will fall on the slit as desired. The identity of the cometary band can be thus established better than with the objective prism. After spectrograms of the comet have thus been obtained, it will also be desirable to obtain plates with the slit as narrow as feasible, in order to detect duplicity or complexity of the lines or bands.

Observations with powerful stellar spectrographs of the types in use for determining radial velocities will doubtless be made as soon as the comet's brightness permits, but this is likely to be disappointingly late on account of the heavy loss of light in such instruments. The fixed equipment of these instruments will determine their operation by their regular observers.

PHOTOMETRIC AND POLARISCOPIC OBSERVATIONS.

Photometric and polariscopic observations of the comet should certainly be made, although they will doubtless occupy a position of subordinate importance. The suggestions of the committee in this respect are formulated by Prof. Pickering, as follows:

A great variety of methods may be employed for measuring the light or amount of polarization of the comet. It is suggested that astronomers undertaking this problem should correspond with the chairman of the committee, in order that uniform methods may be employed throughout by different observers. The plans proposed below may require modification, according to the instruments available.

A direct estimate, by Argelander's method, of the entire light of the comet, as seen by the naked eye, or in the smallest telescope with which it is visible, may have a certain value to observers in the future, although large systematic errors are to be expected in such estimates.

It is doubtful if photometric measures of the nucleus of the comet will have much value, as the results will probably be greatly affected by the coma, and will differ with different photometers and telescopes. If the nucleus be distinctly stellar it may be compared directly with an adjacent star, by means of a double-image photometer. The effect of background would thus be eliminated. Direct measures with a Zöllner photometer, or similar instrument, would probably have but little value, owing to the effect of the coma. Any series by the same observer with the same instrument would be valuable by itself, and the observations by different persons and different instruments might be subsequently adjusted for systematic differences.

The measures described in Harvard Circular 68 showed that the absorption of light by the tail of comet 1902*b* was certainly less than a tenth of a magnitude. Similar measures should be made of Halley's comet. A double-image photometer is indispensable for these measures also, to eliminate the effect of background.

The light of different portions of the tail of the comet may best be measured by the following method. Take two photographs at the same time with similar instruments, using the same kind of plate and developer, and giving equal exposures, taking one in focus and the other out of focus, so that the images of the stars shall appear as circles two or three millimeters in diameter. Make similar enlargements of the two plates, interposing screens of perforated brass. Measures of the opacity of the resulting circular images of different portions of the comet on one plate may be compared with the images of stars the magnitudes of which are known as photographed on the other plate. The effect of the light of the sky or of twilight may thus be eliminated, and the light of the comet compared with that of a star of known magnitude spread over a standard area. The two photographs may also be compared directly with a suitable photometer.

Messrs. Barnard and Frost, having also the benefit of Mr. Parkhurst's opinion, suggest as an alternative and possibly better method the extra focal use of a single camera. The intensity of the extra-focal cometary image could be reduced to the focal plane as accurately as for the star images. The relative values on different nights would always be correct.

Useful suggestions for the photometric observations of the comet may be derived from a paper by Dr. Rosenberg upon photometric observations of the Morehouse comet, contained in the Astrophysical Journal for November.

The polarization, if any, of the comet's tail may best be studied by photographs taken with a camera having a double-image prism placed over the lens. The prism should be turned so that the two images are perpendicular to the direction of the sun. The two images of an unpolarized object should be alike if the correction for color is the same for both, otherwise it will be necessary to take a second photograph, turning the prism 180 deg. If the light is polarized, one image may be fainter than the other, as in similar photographs of the solar corona. Measures may be made as described in the preceding paragraph.

Bands will doubtless be seen if the comet is examined by means of a Savart's polariscope or similar instrument, but it is, in that case, difficult to distinguish between slight polarization of the comet and the strong polarization of faint sky-light.

MINOR NOTES.

The following titles may be specified as minor matters not included above, but which may in some circumstances become of importance, viz.:

The head of the comet should be carefully examined for traces of phase. Possible disturbances may be found in the comet, due to its close approach to Venus on May 1st and to the earth on May 18th. A transit of the earth through the comet's tail is possible at or near the latter date, and, if such should occur, a meteoric shower should be looked for and observed with reference to a determination of the meteoritic particles, their frequence, size, etc. Resultant disturbances of the electric potential of the earth's atmosphere are possible, and the co-operation of meteorological observers, and especially of national weather bureaus, is earnestly desired in this connection.

Although the amount of refraction experienced by light in transit through a comet is known to be very small, it seems desirable to make investigation of the matter photographically with long-focus telescopes. The position of a sufficiently bright star near the nucleus, or in the brightest part of the edge of the tail, should be referred to a group of more distant ones, and the resulting position of the star compared with that resulting from another plate exposed after the comet has left the star.

THE OPTICAL METHOD OF STUDYING IMMUNITY TO BACTERIAL DISEASES.

By DR. H. A. GINS.

CERTAIN substances possess the property of rotating the plane of polarization of light. Sugar is one of these substances, and the percentage of sugar in a solution is estimated in sugar refineries, by measuring the angle through which the solution turns the plane of polarization of a beam of polarized light which is passed through it.

Abderhalden has recently extended the field of usefullness of the polaribeter to the study of the changes which take place in the blood during the formation of the substances which the organism produces, as antidotes to bacteria or poisons, which have entered the blood, and has obtained very promising results.

Some of Abderhalden's experiments were made on peptones. These are the comparatively simple, but still very complex, products of the first stage of decomposition of albuminous or proteid substances. The chemical constitution of peptones is not yet accurately known, but it is possible to split them up into still simpler compounds, the amino acids, which are more thoroughly understood.

In general, when a solution containing a peptone and a ferment is placed in the polarizing apparatus, the plane of polarization is rotated by an amount which does not, at first, remain constant, but either increases or decreases. Ferments are complex substances which possess the power to decompose, or subdivide, other compounds. Numerous ferments are found in the animal organism. One is the pepsin of the stomach, which digests albumen, a second is diastase, which converts starch into sugar, and there are many others. The rotation of the plane of polarization of the beam of light, which traverses the mixture of peptone and ferment, indicates the precise manner in which the ferment acts on the peptone. For example, let us suppose that a certain peptone, *abc*, which turns the plane of polarization 30 deg. to the right, is known to be composed of the three amino acids, *a*, *b* and *c*, of which *a* turns the plane of polarization 5 deg. to the right, while neither *b* nor *c*, alone, exerts any rotary action. One ferment may separate the peptone *abc* into the two parts, *a* and *bc*, a second ferment may yield the two products *ab* and *c*, a third may resolve the peptone into the three amino acids, *a*, *b*, and *c*, and so on. As a rule, each of these reactions will produce a different change in the amount by which the plane of polarization is rotated by the mixture. Hence, by observing this rotation, the parts into which the peptone is divided by the ferment can be determined, and the nature of the ferment can be deduced. The assumption made in this hypothetical case has been confirmed by Abderhalden's researches.

In order to secure absolutely unequivocal results, Abderhalden used, in his first experiments, a peptone obtained from milk, and employed as a ferment, the liquid extract expressed from yeast, which was known to separate that peptone into certain definite amino acids. He next mixed the blood serum of normal rabbits and dogs with this peptone and found that the position of the plane of polarization of light which traversed the mixture remained almost unchanged. This result proved that the normal serum exerted little, if any decomposing action upon the peptone. A very different result was obtained when the peptone was mixed with serum obtained from animals which had been treated with hypodermic injections of the same peptone.

Recent researches have shown that animal organisms possess natural means of defense against the attacks of invading disease germs and their poisonous secretions, or toxines. If a man, for example, has become infected with typhoid bacilli, his body reacts to the infection by producing substances which are poisonous to those bacilli, and which confer immunity to typhoid for a long period, often for life. The blood of this man, when mixed with typhoid bacilli, even outside of the body, coagulates them and makes them harmless, but no such property is exhibited by the blood of a person who has never been infected with typhoid.

In like manner, the blood serum of the rabbits and dogs, which had received hypodermic injections of the peptone, acquired the power to act as a ferment upon that peptone. This property was made evident by the change in the rotation of the plane of polarization of a beam of light passing through the liquid. This action ceased when the mixture was heated to 149 deg. F., showing that the protective or immunizing power of the serum is destroyed by heating to that temperature.

These experiments extend the hope that we shall soon be able to study, by a comparatively simple method, the processes which take place in the blood of an organism infected with bacterial disease, and which have hitherto required, for their observation, methods which are difficult, tedious, and yet imperfect.—Umschau.

THE EFFECT OF LIGHT AND ULTRA-VIOLET RAYS.

A SERIES of experiments on the action of light and ultra-violet rays upon the red corpuscles and pigments of the blood has been made by Hasselbalch, in the laboratory of the Finsen Institute of Copenhagen. Starting from the fact, established by an earlier research, that exposure to ultra-violet rays diminishes the capacity of blood to absorb and evolve oxygen, Hasselbalch proceeded to determine the nature and conditions of this and analogous effects exerted by rays of short wave length on certain derivatives of hemoglobin. He also studied the liquefying action of light on blood and the action of certain photo-biologic sensitizers on blood pigments and corpuscles.

The experiments were performed with fresh, defibrinated ox blood, and the washed corpuscles obtained from it, and also with solutions of oxyhemoglobin. The source of radiation was a Kromayer mercury vapor lamp, operated with 3.6 amperes and 120 volts, which furnished rays of all wave lengths between 600 and 220 $\mu\mu$. (The visible spectrum extends approximately from 700 to 400 $\mu\mu$. The symbol $\mu\mu$ denotes one millionth of a millimeter.) In some experiments the extreme ultra-violet rays were cut off by placing before the quartz window of the lamp a plate of ordinary glass, or one of "Uviol" glass, which eliminated all waves shorter than 310 $\mu\mu$ or 250 $\mu\mu$, respectively.

The experiments proved that the natural coloring matter of the blood is converted by the rays of the Kromayer lamp into meta-hemoglobin, which subsequently forms hematin and other products of polymerization. The presence of oxygen is necessary for this reaction, as deoxidized hemoglobin is not affected by the rays. The strongest action is exerted by rays of wave length 310 $\mu\mu$. The reaction takes place at the same rate, whether the oxyhemoglobin is in solution or in the red blood corpuscles.

Meta-hemoglobin exposed to the rays in vacuo is converted into hemoglobin, but in darkness oxyhemoglobin is formed by the action of the liberated oxygen.

Hematin is reduced by the rays to hemochromogen, from which it is re-formed in the dark.

Oxycarbonated hemoglobin is partially converted into hemoglobin by the rays, and is re-formed in the dark.

Both in air and in vacuo, the red corpuscles dissolve under the influence of the rays. The greatest effect is produced by wave lengths shorter than 310 $\mu\mu$, but the rays of the visible spectrum exert an appreciable solvent action.

All the actions exerted by the rays in the presence of air are accelerated by the addition of color sensitizers, but in vacuo these substances accelerate only those reactions in which oxygen is liberated. A sensitizer, for the reactions studied in these experiments, is a substance which strongly absorbs light and is easily oxidized.

HOW TO PROVE THAT YOU REACHED THE POLE.

THE SCIENTIFIC PREPARATION AND EXAMINATION OF RECORDS.

BY J. HAMMOND SMITH, UNIVERSITY OF PITTSBURGH.

EXPLORERS of all ages have generally carried with them the best obtainable data and instruments for the ready determination of geographic position. These include maps and descriptive data, which are invaluable for showing the relative positions of physical features of the land and bodies of water, and instruments for the determination of latitude, longitude, and elevation above sea level.

In polar expeditions, the maps alone will serve the explorer until he reaches unknown lands or waters, unless he desires to find his position at sea, or check his maps or other data. But as he travels onward into unknown regions, it will be necessary for him to determine his position by means of instruments. He can determine his elevation by observations on the pressure of the air, which are made by means of the aneroid barometer, or by the temperature of boiling liquids. The most important observation, however, is the one which determines his latitude. This observation is made by measuring the altitude of a celestial body; generally the sun, as it crosses the observer's meridian, or at its highest or lowest position in the heavens, when it can be seen. The instruments used for this observation are a pocket sextant, a very small and compact instrument, yet one of considerable accuracy when properly used; and an "artificial horizon," which is simply a plate of black glass with level vial attached. The angle between the sky image of the sun, and the image reflected from the artificial horizon is measured by means of the sextant. The declination or angle between the plane of the equator and the position of the sun must also be known, and can be determined, for the time of observation, from the data of the solar ephemeris, which the explorer must carry with him.

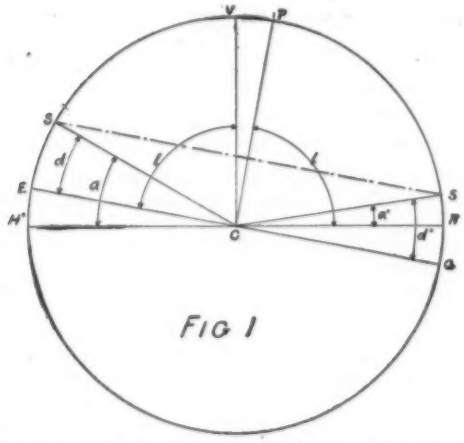


FIG 1

FIG. 1.—POLAR SECTION OF THE CELESTIAL SPHERE.

In order to explain the methods of taking and reducing observations, let Fig. 1 represent a polar section of the celestial sphere, taken through the position of the observer. Then C represents the position of the observer, V his zenith, and $H'R$ his horizon. EQ the equator, P the pole, and S and S' the positions of the sun at its greatest and least altitudes respectively, or at positions on the observer's meridian. The altitudes being represented by a and a', the declinations by d and d', respectively, and the observer's latitude by 1.

DATE 1909	EASTERN STANDARD TIME	MEAN SOLAR TIME	APPROXIMATE ALTITUDE OF SUN	a or a' ALTITUDE OF THE SUN AS MEASURED AND CORRECTED FOR REFRACTION AND PARALLAX	d DECLINATION OF THE SUN	d DECLINATION OF THE SUN	LATITUDE	MILES FROM THE POLE
APRIL 15	1:15 P.M.	NOON	39° 45'	11° 39'	9° 4' 15"	8° 49' 1"	81° 35'	197.
" 15	2:30 "	"	11° 30'	11° 51'	9° 26' 4"	9° 26' 4"	88° 33'	134.5
" 17	3:20 "	1:30 P.M.	35° 0'	11° 37'	6° 58' 16"	10° 33' 16"	88° 41.6	91.5
" 19	1:40 "	NOON	190° 0'	11° 35'	9° 23' 0"	9° 19' 35"	89° 22'	44.
" 21	1:40 A.M.	MIDNIGHT	190° 0'	11° 34'	9° 30' 0"	11° 49' 48"	89° 47'	13.
" 21	2:15 P.M.			12° 0'	9° 21' 0"	11° 53' 7"	89° 53.3	.8
" 21	10:00 "			12° 6'	9° 19' 0"	12° 1' 48"	90° 0'	0
" 22	6:00 A.M.			12° 13'	9° 16' 0"	12° 8' 24"	89° 53.5	.8

TABLE I

Then:

$$1 = 90° - (a - d), \text{ or}$$
$$1 = 90° + (a' - d')$$

In order that we may understand the methods of using these equations, let us assume that we have the explorers' data before us as shown in Table I.

For example, the observation of April 15th was taken when the sun was observed to be highest in the heavens. This was at 2:30 P. M. eastern Standard time. The altitude observed at this time was 11° 51′, and the correction for atmospheric refraction and parallax, found from tables, was 4′26″, making the corrected altitude $a = (11° 51') - (4' 26'') = 11° 46' 34''$. The declination of the sun, found from the tables of the solar ephemeris, was 9° 50′ 4″. Then by use of the equation:

$$1 = 90° - [(11° 46' 34'') - (9° 50' 4'')]$$
$$1 = 90° - (a - d)$$

The latitude = 88° 3′ 30″.

The longitude of the observer's position may be determined by noting the time at which the sun crosses the meridian. For instance, if the explorer's chronometer is set on eastern standard time (mean time of the 75th meridian) and the sun is observed to reach its greatest altitude at 1:40 P. M., the longitude of the place is:

$$75° + 15° \times 1\,2/3 = 100° \text{ west of Greenwich.}$$

But the importance of exact longitude grows less as the distance from the pole decreases. At the equator one (1) degree of longitude is equal to about 69.25 miles, while at 200 miles from the pole it is about 3.49 miles, and at the position shown in observation of April 19th, which is 44 miles from the pole, one degree equals only about 0.77 mile.

If it be assumed that the observation of April 19th were taken when the sun was on a meridian 8° in longitude ($t = 8° = 6.16$ miles eastward or westward) from the position of the observer, we obtain the following results:

$$\tan D = \frac{\tan d}{\cos t} \text{ from which}$$
$$D = 11° 30.5', \text{ then}$$
$$\cos (1 - D) = \frac{\sin a \sin D}{\sin d}, \text{ or}$$
$$1 - D = 77° 50.4', \text{ and therefore}$$
$$1 = 89° 20.9'$$

Giving the position as 1.1′ or about 1.25 miles farther from the pole than the result given in the table, which was found by assuming the sun to be on the observer's meridian at the time of observation. This clearly shows that large errors in longitude, or time, can have little effect on practical determinations of latitude in the polar regions.

By a careful examination of the foregoing observations (all assumed) and the latitudes deduced, the reader will be convinced that it is possible to "fake" observations. Therefore, when an explorer returns with his narrative of having reached the pole, a complete and perfect set of observations, and a large collection of photographs, taken at random, do we thereby have complete proof that he has actually reached the pole? If the explorer's veracity is omitted from the deduction, we think the proof is far from being complete. And it is none the less certain that it is very difficult to make it complete.

As a possible aid to the proof the writer suggests the following method:

When the explorer has closely located the position of 90° latitude by means of his sextant, he may bring his camera into use, to take a systematic set of photographs of the whole visible horizon, with the sun showing its altitude, and casting shadows of objects arranged in the foreground around the camera.

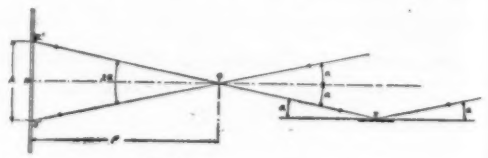


Fig 3

FIG. 3.—USE OF ARTIFICIAL HORIZON IN AIDING PHOTOGRAPHIC PROOF.

Sketches 1 to 8 in Fig. 2 show the principle of this method. The photographs should be taken in such a manner as to include a complete panoramic view of the horizon, with the pictures either continuous or overlapping. The artificial horizon may be used as a possible aid in this photographic proof. It may be leveled in front of the camera, in the proper location to reflect the image of the sun on the photographic plate. Fig. 3 will serve to make this principle clear. H represents the photographic plate; O the optical center of the lens, and Z the artificial horizon. Then if the altitude of the sun is a, it is evident that the angle be-

FIG. 2.—PRINCIPLE UNDERLYING PHOTOGRAPHIC PROOF.

tween the direct and reflected beams will be $2a$, and can be measured with reasonable accuracy on the photographs by means of one of the following methods:

(1) $\frac{A}{2F} = \tan a$. In which A is the distance between the images of the sun in the sky and in the artificial horizon on the photograph; and F is the focal length of the lens.

(2) $\frac{L}{360} = S$. In which L is the total length of the panoramic photograph and S is the distance on the photograph which represents one degree. For instance, if $L = 36$ inches, $S = \frac{36}{360} = 0.10$ inch, or 1/10 inch on the photograph represents one degree.

If $A = 2.42$ inches on photograph 2, Fig. 2, then $2a = \frac{2.42}{0.10} = 24.2°$, or $a = 12.1° = 12° 6'$.

If the artificial horizon is not used, a straight line representing the average horizon may be drawn, and the altitude of the sun measured directly from this line.

Photographs showing the sun must first have a quick exposure, with small aperture, or a colored screen may be used over the lens, to get the images of the sun: then to get the details of the picture, an ordinary exposure is made, with lens shielded from the sun, and the artificial horizon covered. The sun with shadows must show in at least three of the photographs. The largest possible number of photographs should be taken, in order that a large number of the plates may be developed after the return of the expedition.

HYDRAULIC MOTORS AND PUMPS.

PROF. HELE-SHAW'S LATEST INVENTIONS.

PROF. HELE-SHAW, F.R.S., has lately patented some interesting improvements in connection with a hydraulic machine, which can be used either as a pump or as a motor, and which is of the type wherein radial cylinders rotate around a stationary valve having a diaphragm dividing its induction and eduction ports, and pistons within the cylinders derive reciprocating movement from an eccentrically situated ring, this ring being adjustable in position to produce variable stroke and reversal. In apparatus of this kind previously proposed, the pistons have been definitely connected to the eccentric ring, but the present improvements consist of a particular construction of such apparatus wherein the pistons are not in any way connected with the ring from which they derive reciprocating motion or to which rotary motion is imparted by them.

As a consequence of this detachment of the piston heads from the eccentric ring with which they are associated, it is necessary to provide means for maintaining the piston heads in working relation with the eccentric ring, and another important feature of the device consists of an annular ring or annular rings by which this is effected.

Fig. 1 is a sectional elevation of a form of the apparatus specially designed for use as a pump.

Fig. 2 is a similar view of a modified form of the apparatus specially designed for use as a motor.

Fig. 3 is an elevational view, partly in section of Fig. 1.

Fig. 4 is a sectional elevation of the slipper employed.

Referring to Fig. 1, A designates the induction pipe and B the eduction pipe of a construction of the apparatus designed primarily for use as a pump.

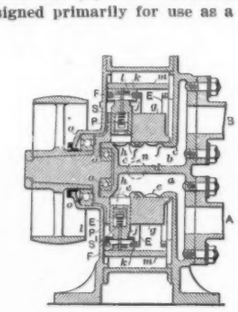


FIG. 1.

These pipes A and B are connected respectively to the low and high-pressure sides a and b of a central cylindrical stationary valve c, the high-pressure side b of which is divided from the low-pressure side a by means of a longitudinal diaphragm d. This cylindrical valve c has inlet and outlet ports e and f respectively cut in it, and a cylinder body g is mounted to rotate upon this valve so that the open ends of the cylinders h co-operate with these ports as the cylinder body g rotates upon the stationary valve c. The cylinders h are arranged in the cylinder body, preferably in more than one row, and the cylinders of one row are staggered in position relative to the cylinders in the next row. The cylinder body is connected up to a driving wheel or pulley i, by means of which the cylinder body is, when the pump is in operation, continuously driven. Pistons j work in the cylinders h, and these pistons carry at their outer ends slippers k, which are capable of rocking on the pivotal heads l of the pistons. Surrounding these pistons and cylinders a ring or drum m is arranged, which is capable of having its axis moved by means of the rods n to various positions on either side of the main axis of the apparatus, which is, of course, also the axis of the cylindrical valve c. The axes of the cylindrical valve c and the drum m are always either coincident or parallel. In operation the cylinder body g is continuously rotated, ball bearings o preferably being provided to reduce friction. If the axes of the valve c and the drum m are coincident, the slippers k merely rotate in contact with the inner periphery of the drum, and no flow of liquid takes place. If, however, the axis of the drum is moved so that it is situated eccentrically in relation

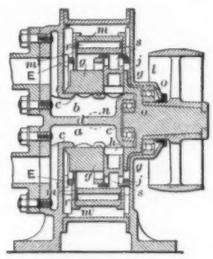


FIG. 2.

to the valve c, the reciprocating movements will be imparted to the pistons j, and this reciprocation will cause fluid to enter the valve and cylinders from the pipe A on the low-pressure or suction side a of the diaphragm, and be expelled through the pipe B on the high-pressure side of the valve.

By this means a continuous flow of liquid is assured. By altering the relative positions of the axes of the valve c and drum m—that is to say, by altering the degree of eccentricity between the valve and drum—the length of the stroke of the pistons is altered, and thus an effective variable stroke pump is provided. If, instead of utilizing the apparatus as a pump in the manner being described, fluid under pressure is supplied through one or other of the passages a and b of the valve c, the apparatus will operate as a motor, the reciprocation of the pistons j causing the slippers k to so operate, in conjunction with the inner periphery of the drum, so as to cause the bodily rotation of the cylinder body g and its attached wheel or pulley i, and it follows that the speed of rotation of the wheel will be infinitely variable at will by varying the stroke of the pistons in the manner previously described.

Where, however, a motor is required, it is preferable to employ the particular design shown in Fig. 2, which, although operating in accordance with the same principles as the apparatus before described, differs slightly in matters of construction.

The differences in this construction are, however, confined to the prevision of a floating liner or inner drum m^1 capable of rotation within the non-rotatable drum m, rollers r being interposed between two drums. In addition to this, the slippers k carried by the piston heads, in the construction shown in Fig. 1, are replaced in this instance by rollers s. The action of the apparatus is exactly similar to that of the form shown

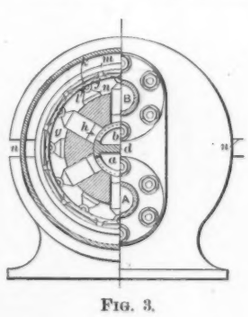


FIG. 3.

in Fig. 1. That is to say, fluid under pressure within one or other of the passages a or b of the stationary valve c will cause the reciprocation of the pistons j, and the rollers s, operating against the inner periphery of the floating drum or liner m^1, cause the bodily rotation of the cylinder body g and its attached driving wheel. In order to insure the piston heads, carrying either the slippers k or the rollers s, always being held up to their work, a ring E is provided in connection with each machine, in which ring the heads of the pistons engage, this ring always maintaining position concentric with the eccentric ring or drum m. By this means the pistons are always maintained in proper working relation to the ring or drum, or, in the construction shown in Fig. 2, to the inner floating liner m^1 of the ring or drum.

In order to provide against any tendency of the slippers k to adhere to, or frictionally grip, the ring when pressure is applied, a forced lubrication or pressure balancing device shown in Fig. 4 is employed.

In this case the piston proper j has a small piston P within it, a spring s^1 serving to keep the small piston out until the pressure rises sufficiently to overcome the pressure of the spring. The pistons proper are bored right through, and the passages thus formed run into passages F leading to the surface of the slipper k. It will thus be seen that as the pressure rises, oil is forced out of the passages F, and the pressure fluid seeks to lift the slipper from the drum, and as a consequence the slipper floats off on a film of oil—when oil is the fluid with which the casing is filled. Immediately the pressure upon the small piston is so much reduced that the spring can operate to move, such movement will cause the piston to be again replenished with oil or other fluid from the outside casing through the passage G fitted with a non-return valve.—The Practical Engineer.

IGNITION VELOCITY AND EFFICIENCY OF EXPLOSION MOTORS.

IN explosion motors the velocity of ignition is always much smaller than the theoretical value, and

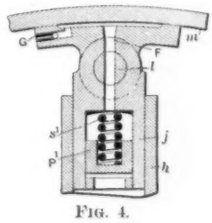


FIG. 4.

can be determined only by experiment. It depends on the quantity, composition and igniting point of the gaseous mixtures, the amount and temperature of compression, the position of the igniter, its temperature and the quantity of heat furnished by it, and the speed of the piston. The velocity of ignition increases with the volatility of the combustible and the approximation of the proportions of the mixture to those of instantaneous ignition or explosion. Witz finds that the velocity of combustion and the efficiency increase with the speed of the piston. Compression is very advantageous up to 5½ atmospheres, beyond which point there is danger of spontaneous ignition.

A collapsible steel dam has, says the Engineering Record, been in use for some time in Bear River Canyon, near Garland, Utah, about thirty-five miles above the point where this stream empties into Great Salt Lake. It is essentially a steel crest, built upon an existing crib dam of the Utah Sugar Company, which may be lowered to reduce the water level on the upstream side and enable driftwood and floating matter that might injure the structure to be carried off. In order to place the steel dam in position it was necessary to cut down the old dam 5 feet, so that when the steel portion had been built its crest was at the same heights as that of the original dam. The steel addition is hinged to the main structure in such a way that it may be folded into a longitudinal pocket or slot reducing the height about 4 feet and eliminating the danger of water cutting around the ends of the structure during floods and washing out the canals and headgates.

IS ETERNAL LIFE POSSIBLE ON THE EARTH?

THE VITALITY OF SEEDS.

EVERY one has heard of the grains of wheat which have been found in Egyptian sarcophagi and which, when sown, have sprouted and grown like ordinary wheat, proving that they had retained their vitality for thousands of years. In Pompeii, also, has been found wheat which is alleged to have preserved its power of germination. We are told that plants of various sorts have been raised from seed found in Gallo-Roman graves, and in Peruvian graves dating back at least 500 years before the Inca dynasty.

Many treatises on botany and forestry contain the assertion that, after extensive tracts of timber have been cleared, many species of plants, formerly unknown in the forest, often appear. The inference is that these plants spring from seeds which have lain dormant in the ground for centuries, awaiting conditions favorable to their germination and growth. Another familiar story is that of the microscopic animal organisms, known as infusoria and rotifera or wheel animalcules, which, when desiccated, retain their vitality for indefinite periods and immediately become active when they are placed in water. Assertions of this character, which formerly met with universal acceptance, led Claude Bernard to his conception of latent life. Bernard distinguished three principal forms of life: manifest, retarded, and latent. In manifest life, respiration, metabolism and other physiological processes go on briskly. The chief characteristic of manifest life is the formation of new tissue or, at least, the continual renewal of cells, which are the elements of tissue. In retarded life the physiological processes are performed less energetically and the organism prolongs its existence only by consuming nutriment which it has previously stored up. There is no formation of new tissue, no substitution of new cells for those which have died, but some elements of the body are kept alive by the destruction of other elements. The hibernation of certain animals and the winter life of bulbous and tuberous plants are examples of retarded life. In latent life all physiological activity is arrested, there is no exchange of matter between the organism and the external world, by respiration, transpiration or otherwise, and inside the body there is no construction, destruction or alteration of cells. Examples of latent life are furnished, according to Bernard, by the seeds, spores, and eggs of plants and animals, and by the desiccated infusoria and rotifera mentioned above.

According to Gaston Bonnier in Kosmos, when we examine attentively the stories of the germination of seeds found in medieval, Gallo-Roman and Celtic graves we find that the plants alleged to have sprung from those seeds were, usually, such very common weeds as mercury, bindweed, cornflower and camomile, which would very likely have appeared even if no seeds had been sown, as no precaution seems to have been taken to prevent the access of weed seeds. These haphazard experiments resemble those which are brought forward as evidence of transmutation of species. Seed of one species is sown, plants of a different species appear, and it is inferred that one species has been transformed into the other. For example, if I sow some wheat, not knowing that it has lost its power of germination, and poppies spring up, I must, according to this method of research, conclude that wheat has been changed into poppies.

This idea of the longevity of seeds is so firmly rooted in the minds of a majority of educated persons that the most absurd errors have been committed. Prof. Heldreich, of Athens, saw the yellow horn poppy (*Glaucium flavum*) growing on ground from which a thick layer of mine refuse had lately been removed. As the scoria came from an ancient Greek mine and had been thrown on the site 1500 years previously, the botanist concluded that the seeds of the horn poppy had lain buried for that length of time. This plant is especially prolific of astonishing phenomena. An English botanist is said to have found horn poppies growing in the débris of rocks of the secondary formation, which had been covered by a lias deposit, and to have inferred that the plants sprang from fossil seeds, which had retained their vitality from that remote geological period. This reminds me of an article which appeared in the Paris Figaro, at the time when the foundations of the basilica on Montmartre were laid. The journalist, a man of scientific education, having seen many plants growing from the sides of the deep excavations which were dug in the gypsum rock in the preceding year, assumed that these plants sprang from seeds deposited with the gypsum, in the eocene, or beginning of the tertiary period, millions of years ago. I showed this article to many well-educated persons, but not one of them either expressed great astonishment or suggested that the seeds might have been brought by the wind. If you tell a man that you have been bitten by a fossil crab he will think you demented, but if you tell him that you sowed fossil seeds and they grew, he recalls the famous mummy wheat and deems the occurrence remarkable but not improbable.

Now let us turn to statements which have basis of fact. Seeds of the sensitive plant (*Mimosa sensitiva*) have germinated after having been kept sixty years. Much has been made of the single bean, gathered by Tournefort, which is said to have sprouted after it had lain a hundred years in the herbarium, but other beans from the same pod failed to sprout, when tested by another experimenter. A century is very short in comparison with the age of eocene deposits or even that of Egyptian mummies. If the life of seeds is entirely latent and they are protected from external influences by being kept in closed vessels, they should infallibly retain their power of growth, but gardeners and seedsmen know that this is not the case.

In 1846 Alphonse de Candolle sowed, in the most favorable conditions for germination, many seeds of 368 species, which had been kept fifteen years. Of 351 species not a single seed germinated, and in most of the remaining 17 species the number of seeds that sprouted, out of 20 sown, varied from 1 to 3.

Similar results have been obtained from experiments with the microscopic animal forms, infusoria and rotifera. In 1907 Richters described his experiments with rotifera which he found in Spitzbergen moss in vast numbers—30 animalcules in each grain, or 13,000 in each ounce, of the dried moss. Experiments with one species (*Macrobiotus coronifer*) yielded the following results: Kept dry for 9 months, they returned to manifest life after 25 minutes' soaking and shaking. After 15 months of desiccation, 35 minutes' immersion in water was required to restore their activity. After 22 months, some but not all of the animalcules were revived by an immersion extending over more than an hour, and after 30 months of desiccation none could be brought back to manifest life. These experiments prove clearly that the life of the animalcules, in the dry state, is not the latent life of Bernard's classification, but is marked by very slow physiological and chemical changes which ultimately make return to manifest or active life impossible.

In conjunction with Van Tieghern, I have made some experiments for the purpose of determining whether or not any perceptible exchange of gases occurs between seeds and their environment. We found that dry seeds absorbed very small but measurable quantities of oxygen and exhaled very small but measurable quantities of carbon dioxide. In other words, the seeds breathed, though very feebly. We also detected a very slight exhalation of water vapor.

Hence we concluded that respiration continues in organisms which are commonly regarded as being in the condition of latent life, and that the organisms die when respiration ceases. The life of such organisms, therefore, is not strictly latent, but only dormant, or retarded. Our results have been contested by adherents of the theory of absolutely latent life. Casimir de Candolle asserts, without supporting the assertion by experimental evidence, that the slight respiration which we detected can occur only in fresh seeds, which have not yet passed from the condition of retarded life into that of absolutely latent life. Yet some of our seeds were several years old.

Kolkwitz has recently obtained results identical with ours. He finds that perfectly dry barley absorbs oxygen and exhales carbon dioxide. The respiration is increased by crushing the grains and is not arrested by grinding them and steeping them for several hours in boiling water or 90 per cent alcohol. Paul Becquerel has repeated these experiments with a great variety of dry seeds and has confirmed the regular occurrence of respiration and transpiration as long as life remains—even in some exceptional seeds which still retained the power of germination, although they were eighty years old.

Let us return to the seeds found in the graves of the Pharaohs. The only striking peculiarity in the external appearance of such seeds is their color, which is generally reddish brown. According to analyses made by Bonastre in 1828, the so-called "albumen," stored in the seed, close to the embryo, which it supplies with the nutriment required for germination, contains several organic substances which remain unaltered for ages. The starch of these seeds was colored blue by iodine, like freshly-formed starch. This is a remarkable discovery, which proves that some organic compounds may be preserved indefinitely, in appropriate conditions, but it does not prove that the seeds which contain these compounds will germinate. For germination, at least three conditions, which have recently been formulated by Prof. Gain, of the university of Nancy, must be satisfied. 1. The food reserves must be chemically unaltered. 2. The embryo must still be able to secrete the liquid by which the food is digested. 3. The embryo must remain in contact with the food supply. The first condition is satisfied in much of the grain found in Egyptian graves, but the other conditions are not satisfied. Gain has discovered, by microscopic examination of sections, that the embryos of these grains are usually shrunken and disintegrated and that their individual cells fail to show the reactions characteristic of the cells of living embryos. Hence the embryo is both detached from the food reserve and unable to produce digestive juices.

Gain arrives at the following conclusion: "The seeds found in Egyptian graves, though apparently well preserved, no longer possess the cellular structure required for germination. The food reserve often shows little chemical alteration, but the embryo has undergone extensive chemical changes, which prove that even the retarded life of the seed has long been extinguished." Gain has classified seeds according to age, from the appearance of thin sections under the microscope, thus following the successive stages of the internal changes wrought by time in the apparently unaltered seeds.

Still more recently Gain and Brocq-Rousseau have studied both the germinating power and the digestive diastases of seeds of various ages, ranging from 2 to 3,000 years. The seeds were obtained from 12 botanical and archæological collections, and included seeds from ancient Peruvian tombs. In general, the diastases were preserved longer than the germinating power, but in no instance longer than 200 years, while no seed more than 100 years old could be induced to germinate. Yet men of scientific education are alleged to have actually observed the germination of wheat found in the tombs of the Pharaohs.

The distinguished Egyptologist Maspero, in a letter written to Prof. Griffon, explains this discrepancy as follows:

"A distinction must be made between experiments with seeds purchased from natives and purporting to come from ancient tombs, and experiments with seeds which have been found in the tombs by the experimenters or have been obtained from trustworthy persons. In the former case the seed almost always germinates; in the latter case it never does so, to my knowledge. The inference is obvious. The fellahs adulterate the ancient seed which they sell with at least an equal quantity of new seed; the latter germinates and the former does not. I have found in tombs many seeds of wheat, barley, hemp, flax, and other plants. Some of the seeds had been parched, others had been steeped in lime water, but many had been deposited in the tombs without any apparent preparation. Not a single seed of any of the three classes has germinated."

The question of finding terrestrial position is usually associated with a measurement of altitude, which has either to be taken from the sea-level datum, if the sea horizon is visible, or from an artificial horizon, when the natural horizon is invisible. In many cases, however, neither of these methods are available, and it is desirable to devise some such procedure as would enable the occupants of a balloon, say, to determine their position with sufficient accuracy to warrant their descent on any pre-defined district whose topographical features may not be recognizable. If the error of observation is about half a degree the resulting position would be out by some thirty miles. Mr. C. V. Boys has devised an instrument to do this, of the type of swinging collimator and sextant combined. The collimator is vertical and is suspended on a gimbal frame, the whole being top-weighted like a metronome, so as to have a period of swing of about one second. The collimator is provided with a fine scale adjusted at its focal plane; above the lens is fixed a clear or half-silvered glass mirror set at 45 deg. with the axis of the collimator. The whole is then suspended in a tube, forming the handle of the instrument, to which is attached the ordinary parts of a small sextant. When looking in the telescope the star will be seen projected upon the scale, one half of which is marked +, the other —, and by having the instrument calibrated, these readings may be made to indicate altitudes direct. Without the top controlling weight it is found impossible to hold the instrument steady enough, but when the period is increased to about one second by top-weighting, the angular movement is so reduced that by sitting at a table an accuracy of one minute of arc is possible.—Knowledge.

Letters can now be automatically registered in Berlin by an automatic penny-in-the-slot machine placed in the post offices, which specially stamps the letters and saves the sender from waiting.

INDUSTRIAL FELLOWSHIP IN UNIVERSITY WORK.

CO-OPERATION BETWEEN UNIVERSITIES AND MANUFACTURERS.

BY CHARLES MOREAU HARGER.

No development of industrial effort is more interesting than that connected with the search for better methods of doing things. The constant attempt of the great corporations to secure new ideas and to improve old ones is leading them into new fields. That they should reach into the curriculum of the college and university is but the natural outcome of the scientific side of business life. The student with time and materials at his disposal is especially fitted for searching into hidden fields and it is a curious fact that the most definite effort is being made in one of the western schools, the University of Kansas, where eleven fellowships have been established for the study of special subjects. These are all in the department of industrial chemistry under Prof. Robert Kennedy Duncan.

Prof. Duncan three years ago called the attention of manufacturers to the need of greater efficiency in their methods and suggested that they should keep abreast with the times in making special provision for securing larger results. In magazine articles and books he pointed out the revolution of industrial chemistry and explained the opportunity that lies in many directions awaiting the effort of students. Out of this came the establishment of these eleven fellowships, which are in operation except three recently offered:

1. An investigation into the chemistry of laundering with the object of saving laundered fabrics; $500 a year with ten per cent of the profits.

2. A search for a new diastase, with an attempt to make a new fodder on scientific principles; $500 a year and ten per cent of gross profits for three years.

3. Utilization of the constituents of waste buttermilk primarily caseine and secondarily lactic acid and milk sugar; $500 a year and ten per cent of the net profits.

4. An investigation into the chemistry of baking, established by the National Master Bakers' Association with the object not only of improving the chemistry of bread but as well of providing for the association of a trained expert on whom they could thereafter rely; $500 a year together with a sum to be settled by arbitration.

5. An investigation into the constituents of crude petroleum; $1,000 a year and ten per cent of the net profits.

7. An investigation into the relation between the optical properties of glass and its chemical constitution; $1,500 a year and ten per cent of the profits.

8. The discovery of new uses for Portland cement and of improvement in its manufacture; $1,500 a year and a large additional consideration dependent upon success.

9. An investigation into certain glands of deep-sea mammals; $1,500 a year and an additional consideration to be determined by arbitration.

10. The discovery of new utilities for ozone; $2,000 a year and 10 per cent of the net profits.

11. An investigation into the various methods of chemical treatment of woods to find results of commercial and scientific value; $1,500 a year.

Eight of these fellowships are being worked out; the other three, Nos. 9, 10, and 11 have either not been filled by appointment or not fully established, though all are assured. This is the contract (No. 7) under which they are undertaken:

MEMORANDUM OF AGREEMENT.

"For the purpose of promoting the increase of useful knowledge, the University of Kansas accepts from the A. B. C. Glass Company, having head offices at New York, the foundation of a temporary industrial scholarship to be known as the A. B. C. Fellowship.

"It is mutually understood and agreed that the conditions governing this fellowship shall be as follows:

"The exclusive purpose thereof is an investigation into the optical properties of glass in relation to its chemical constitution, to the furtherance of which the holder shall give his whole time and attention, with the exception of three hours a week, which he shall give to work of instructions in the chemical department.

"The fellow shall be appointed by the Chancellor of the University, the Director of the Chemical Department, and the Professor of Industrial Chemistry; he shall have made previously a reputation in research; he shall be a member of the university, and shall pay all regular fees with the exception of fees for laboratory and supplies, for which the instruction given by him shall be taken in lieu, unless in the opinion of the appointers his demands become excessive, in which case the donor shall reimburse the university; he shall work under the direction and advice of the Professor of Industrial Chemistry; and he shall forward, periodically, through the Professor of Industrial Chemistry, reports of the progress of his work to the A. B. C. Glass Company.

"For the support of this fellowship, which shall extend through a period of two years from the date of appointment of the fellow, the A. B. C. Glass Company agrees to pay $1,500 per year, payable annually to the university on the date on which the fellow begins work at the university. This sum shall be paid by the university in monthly instalments to the holder of the fellowship.

"Any and all discoveries made by the fellow during the tenure of this fellowship shall become the property of the A. B. C. Glass Company, subject, however, to the payment by them to the fellow of ten (10) per cent of the net profits, to be commuted at the desire of either party through the arbitration provided for herein, arising from such discoveries, it being understood that the fellow shall be regarded as the inventor. At any time during the tenure of his fellowship the holder shall, at the option of the donor, take out patents at the expense of the donor on condition that at the time of making application therefor he shall assign his right to the donor under the conditions of this agreement. At or before the expiration of the fellowship, the business services of the fellow may be secured by the A. B. C. Glass Company for a term of three years on condition that the terms of such services are satisfactory to both parties at interest.

"In the event of any disagreement between the donor and holder of this fellowship, it is understood and agreed that the Chancellor of the university, or one whom he may appoint, shall act as arbiter as to all matters of fact, that his decisions shall be binding upon the parties at issue, and that they shall obtain such decision before having recourse to the courts.

"It is also understood and agreed that during the tenure of this fellowship the holder may publish such results of his investigation as do not, in the opinion of the company, injure its interests, and that on the expiration of the fellowship the holder thereof shall have completed a comprehensive monograph on the subject of his research, containing both what he and others have been able to discover. A copy of the monograph shall be sent to the A. B. C. Glass Company, and a copy shall be signed and placed in the archives of the university until the expiration of three years from that date, when the university shall be at liberty to publish it for use and benefit of the people.

"Signed on behalf of the University of Kansas.

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"Date.....

"Signed on behalf of the A. B. C. Glass Company.

.....

"Date.....

"Some of the advantages accruing from these fellowships," says Prof. Duncan, "is that the university gains increased opportunities of promoting research; it obtains three hours a week of gratuitous instruction from men of ability, knowledge, and enthusiasm; the Chemical Department, in particular, obtains the catalytic influence of these men. The manufacturer obtains the advantages of enormously increased laboratory facilities; adequate library facilities, a most important advantage, the lack of which had seriously hampered much factory research; consultative advantages, for the fellow appointed was at liberty to question specialists in the different fields of chemistry, or in other fields of scientific knowledge; complete freedom from supervisional responsibility over the work; and on the termination of the fellowship, the services of a man educated to his particular needs. The fellow obtains all the foregoing advantage ascribed to the manufacturer, and in addition the all-important sympathetic co-operation of the manufacturer, together with inside knowledge of the factory processes, and the university's environment sympathetic to research; also a freedom from all petty interferences and jealousies of shop people, and the pot-shot judgments of factory officials. Finally, if he prove worthy of it, he obtains a position for which he had become, through his training, peculiarly qualified.

"Since at the end of three years all work done under any fellowship must be published free to the public, the public thus obtains new implements of civilization. It is only through the industries that any useful discovery goes to the people. The insertion of this clause had been occasionally resisted for a time, but the donor had always in the end acquiesced, when it was pointed out that a really progressive manufacturer would find three years a sufficient start.

"Since this whole scheme depended upon sympathetic co-operation, it could only be carried out through a professor who regarded it as a sacred trust. It was, therefore, positively necessary that the Professor of Industrial Chemistry should, so far as any material sense was concerned, gain absolutely nothing, otherwise his donors would not trust him with the details of their secret processes, nor would his fellows trust him with their progress."

The problem of meeting the demands of education in the highest sense and at the same time fulfilling the requirements of the industrial world is one that has been made a study by educators for many years and it is believed that this is the most capable solution that has been reached in this country. The activity of the department has been supplemented by the manufacturers' money and it found that the students accomplish much that is worth while. They spend their time enthusiastically and though none of the undertakings have been completed the outlook is favorable for securing very practical results. The equipment needed for the investigations has been furnished partly by the regular facilities of the university and partly out of the added appropriations for this work and it is complete and scientific in every particular. The interest manifested by the students, who show the greatest of pleasure in giving this their attention, is of especial note and indicates that there is among the young men of the universities and colleges a willingness to enter upon such work. That it may be developed to yet greater extent is apparent, and that it has attracted more than local attention is seen from the wide scope of the fellowships offered, coming as they do from the large cities of the East as well as from the West.

The importance of this kind of university work is appreciated by the manufacturers who not only make many inquiries concerning the progress of the work in general but are eager to give all assistance in their power. Many different lines have been proposed that have not yet found the donor of a fellowship fund but which will in the end materialize. The students who are working on the various lines are recognized in the world of commerce. The fellow who is studying bread-making has been invited to make addresses before the master bakers associations in several States this season and his addresses on the chemical processes involved in bread-making have been received with appreciation.

That the university can do a great deal for commerce is being recognized and the start that has been made in this instance is not only unique but has the merit of being of direct use to the business world. Prof. Duncan says one of the most serious problems connected with it is to so adjust the income from discoveries that, while they may be useful, do not actually increase the income of the fellow. This has been the subject of many consultations and will have to be solved before the system enters on its fullest success, when carried on generally. However, the donors have been willing and anxious in every particular to make the arrangement mutually advantageous because it is realized that only by that method can the best results be obtained. The English Society of Chemical Industry devoted one of its sessions last summer to the subject and Prof. Duncan was the principal speaker. His plan received the endorsement of his confreres and was taken as a worthy development of plans that have been followed in Europe for similar accomplishment.

Commenting on a recent discussion by the New York Railway Club on surprise and efficiency tests, a contemporary remarks that even the best of automatic signals cannot prevent collisions. It is necessary to take account of the train crew, as is well shown by the statistics published by the Interstate Commerce Commission. In these it was seen that out of the 152 preventable collisions and derailments during two years, 21 cases were due to negligence on the part of drivers to observe signals. It must be conceded, therefore, continues our contemporary, that the best of signal systems, maintained by a good staff of properly paid men, must be supplemented by something which will teach the drivers the importance of observing all rules and signals. Up to the present there has been nothing devised so good as surprise tests, by which the manner in which signals and rules are obeyed is actually examined and recorded. It is a troublesome and exasperating thing to do, but so is the surprise fire drill required once a week on all passenger steamships.

NUMBER OF TILES FOR A GIVEN AREA.

THE building contractor who at times includes in his operations the setting of the tile will find the accompanying table, reproduced from the Mantel, Tile and Grate Monthly, of great convenience in arriving at the number of tiles of given dimensions and shape required for a given area. After computing the area of the surface to be tiled and having learned from the owner or architect just what size and shape of tiles are desired, it is an easy matter to arrive at the number required by multiplying the area in square feet by the number of tiles given in the table for each square foot of surface.

No.	Shape.	Size in Inches.	Number in Square Foot.
1	Square	6 x 6	4
2	Diagonal ½	6 x 6	8
3	Square	4¼ x 4¼	8
4	Diagonal ½	4¼ x 4¼	16
5	Sq are	3 x 3	16
6	Diagonal ½	3 x 3	32
7	Square	2⅛ x 2⅛	32
8	Diagonal ½	2⅛ x 2⅛	64
9	Square	1½ x 1½	64
10	Diagonal ½	1½ x 1½	128
11	Square	1 1-16 x 1 1-16	128
12	Diagonal ½	1 1-16 x 1 1-16	256
15	Square	2 x 2	36
16	Square	1 x 1	144
17	Oblong	6 x 4	6
18	Oblong	6 x 3	8
19	Oblong	6 x 2	12
20	Oblong	6 x 1½	16
21	Oblong	6 x 1	24
22	Oblong	4¼ x 2⅛	16
24	Oblong	4¼ x 1 1-16	32
25	Oblong	3 x 1½	32
26	Oblong	3 x 1	48
27	Oblong	2⅛ x 1 1-16	64
28	Octagon	6 x 6	4 4-7
29	Octagon Diagonal ½	6 x 6	9 1-7
30	Octagon Square ½	6 x 6	9 1-7
31	Octagon Square ¼	6 x 6	18 2-7
32	Hexagon	6 x 3	10 2-3
33	Hexagon Long ½	6 x 3	21 1-3
34	Hexagon Short ½	6 x 3	21 1-3
35	Octagon	3 x 3	18 2-7
42	Hexagon	6 x 5 3-16	6 1-6
43	Hexagon Diagonal ½	6 x 5 3-16	12 1-3
44	Hexagon Square ½	6 x 5 3-16	12 1-3
48	Pentagon	5 5-16 x 2¼	14 2-9
49	Octagon	4¼ x 4¼	9 1-7
50	Octagon Diagonal ½	4¼ x 4¼	18 2-7
51	Octagon Square ½	4¼ x 4¼	18 2-7
52	Oblong	3 x ½	96
54	Oblong	6 x ½	48
55	Hexagon	4¼ x 2⅛	21 1-3
56	Hexagon Short ½	4¼ x 2⅛	42 2-3
57	Hexagon Long ½	4¼ x 2⅛	42 2-3
58	Square	½ x ½	576
59	Oblong	6 x ⅜	32
60	Hexagon	3 x 3 15-32	18 2-7
61	Hexagon Diagonal ½	3 x 3 15-32	36 4-7
62	Hexagon Square ½	3 x 3 15-32	36 4-7
63	Oblong	3 x ¼	192
64	Hexagon	2 x 2 5-16	41½
65	Hexagon Diagonal ½	2 x 2 5-16	83
66	Hexagon Square ½	2 x 2 5-16	83
70	Oblong	5 x 3	5 1-3
71	Oblong	6 x 4¼	5 11-17
72	Oblong	1 1-16 x 17-32	256
77	Oblong	5 x 10	2 22-25
81	Hexagon	2 5-16 x 2 21-32	31 2-10
82	Hexagon Diagonal ½	2 5-16 x 2 21-32	62 3-5
83	Hexagon Square ½	2 5-16 x 2 21-32	62 3-5
84	Hexagon	1⅜ x 2	54¼
85	Hexagon Diagonal ½	1⅜ x 2	108½
86	Hexagon Square ½	1⅜ x 2	108½
87	Triangle	3	37
88	Half Triangle	3	74
89	Triangle	1 47-64	109 5-7
90	Half Triangle	1 47-64	219 3-7
91	Triangle	1 5-32	249
92	Half Triangle	1 5-32	298

In regard to the above it may be stated that a small number of tile should be added ordinarily to cover breakage and losses.

From a study of the concentric annual layers of growth of conifers growing in various latitudes, between the 60th and 67th parallels, Lemstroem finds that the thickness of the annual layer varies according to a definite law showing maxima and minima which indicate a period of ten or eleven years, coinciding with the period of sun spots and auroras. The differences, furthermore, are greater in the great firs within the Arctic circle, at 67 deg. north latitude, than in trees growing further south. This is quoted as tending to indicate that the atmospheric electricity of the polar regions exerts a beneficial effect upon vegetation.

ENGINEERING NOTES.

A paper read on waterproofing by Mr. Myron H. Lewis before the Municipal Engineers of New York is now issued in pamphlet form. The author limits attention to those branches of work, defined by him as "waterproofing engineering," which relate particularly to means of protecting structures against injury by water and the occupants of structures from discomfort due to the penetration of water. He considers not only methods of treating various substructural conditions, but also the treatment of concrete so as to make it impermeable. He discusses the treatment of the materials and that of the structures in which they are employed before and after erection, above or below ground, and in water. Mr. Lewis is quite right in saying that defective waterproofing is almost worse than none. He is an advocate of the axiom that the best is the cheapest, and in addition to theoretical consideration he goes thoroughly into practical details in a manner which we are sure will be appreciated by our readers. The value of the paper is enhanced by various specifications for waterproofing work, including those adopted for the New York rapid transit subway, the Long Island Railroad tunnel, and concrete bridges on the Chicago and Northwestern Railway.

The following formulas for estimating the approximate weights of bridges of different types (up to 550 feet spans) have been obtained from actual construction, and if there is any criticism to find in them it is that they are too close an approximation. The term "Hot Metal Bridge" applies to a structure having a solid buckle-plate floor system and sides sufficient to provide protection for river and other travel underneath same during the transit of hot metal from furnaces to the mills. (1) Ordinary pin-connected through truss, open-floor system, single track, $W = 7.5\,L^2 + 500\,L$. (2) Do. Double track, $W = 12\,L^2 + 1{,}000\,L$. (3) Double track, through truss, pin-connected, solid-floor system of furnace sand; hot metal bridge. $W = 16\,L^2 + 2{,}800\,L$. (4) Ordinary deck-plate girders, single track, open floor, $W = 10\,L^2 + 350\,L$. (5) Do. Hot metal, $W = 12\,L^2 + 1{,}500\,L$. Where W = total weight of steel work in pounds and L = extreme length in ft. Based on a live load similar to Cooper's class E 50, but with particularly heavy loads on cars suitable for hauling metal around Pittsburg.—Proceedings of the Engineers' Society of Western Pennsylvania.

In addition to the Fades viaduct, of which some particulars were given by us, French engineers are to be credited with the boldly-designed steel bridge for the new railway from Piræus to the Turkish frontier. This structure is about 700 feet long, and spans a ravine some 600 feet from side to side, and more than 325 feet deep at the lowest point. Emerging from a tunnel at either side, railway trains will traverse either one or four girder spans according to direction and then pass over an arch of 262 feet span with the rise of 78 feet, this arch being of the three-hinged type. The five girder spans, each 86 feet long, are supported on lofty masonry piers. The whole of the steel work was prepared in the yard of the contracting firm in Paris, and transported thence by rail. Considering the exceptional facilities possessed by some of our Northeast coast and Scottish firms for the economical production and shipment of structural steel work, it seems a little strange that an inland French company should be able to secure the work. Of course there may be special reasons for this, but in any event it is well that British industrial concerns should recognize the enterprise and marked ability of their friendly rivals in France.

A quantity of water which is rich in iron is now being used for town supplies in Germany, and in these cases the process of preliminary aeration is resorted to in order to remove the bulk of the dissolved iron salts. It is maintained by Mr. Oesten, of Berlin, that such water is liable to reabsorb iron from the mains, and the subject has been vigorously debated. Dr. Noll supposes that the reaction which takes place may be explained by the following equation: As soon as the protective coating on the surface of the iron is worn away and the metal is exposed, we have: $Fe + CO_2 + H_2O = FeCO_3 + H_2$, and if free oxygen is present in the water a separation of iron hydroxide takes place, causing a deposit in the mains. In this case the carbonic acid is liberated, and further iron is dissolved, or the mono-carbonate of iron may be converted into bicarbonate. If the water contains an abundance of oxygen and but little carbonic acid gas a re-combination of carbonate of iron with the water cannot occur, but the amount of hydroxide of iron formed in the mains is larger. If but little oxygen and abundant carbonic acid are present a large amount of bicarbonate of iron will be formed. It is pointed out that in the Hamburg waterworks, since the substitution of filtered Elbe water for the untreated river water, both the cast and wrought-iron mains have been strongly attacked, and Dr. Noll suggests that when river water was in use the organic matters present tended to form a protective slimy coating on the pipes, which prevented the aggressive action of the carbonic acid. The theory of the reaction put forward by Dr. Noll is stated, however, by Mr. Oesten to be inapplicable in the case of the Berlin mains.—Times (London) Engineering Supplement.

TRADE NOTES AND FORMULÆ.

Quick-drying Paint.—10 parts yellow wax, 10 parts linseed oil, 5 parts dammar or rosin, 8 parts of turpentine.

Alloys Casting Delicate Shapes.

Bismuth	6	5	2	8
Tin	3	2	1	3
Lead	13	3	1	5

Alloy for Marking Gage for Printers.—1. Copper, 100; zinc, 13; tin, 10. 2. Copper, 17; zinc, 2; tin, 1. First melt the copper, throw in the zinc, wrapped in paper, then the tin and stir with a stick until the alloy is of uniform consistency.

To matt aluminium immerse the object in strong soda lye until gas bubbles form copiously on its surface, rinse it, lay it in strong nitric acid, and rinse it again. The object will by this means be given the appearance of matt or frosted silver.

Embalming Fluid for Animals, Corpses, etc.—Make a solution of 80 parts of potash, 60 parts common salt, 30 parts saltpeter, and 160 parts of alum, in 6,000 parts of water, heated about 120 deg. F.; add to this a second solution of 18 parts of salicylic acid in 600 parts of methylated alcohol. To the mixture add 60 parts of carbolic acid and 1,800 parts of glycerine.

Luminous Paint.—Mix 100 parts of carbonate and phosphate of lime (obtained by heating or calcining shells) with 100 parts burned lime, then add 25 parts of calcined sea salt and 25 to 50 per cent of the entire quantity (i. e., 66 to 112 parts) of sulphur, finally admix 6 to 7 per cent of a luminous substance made from a combination of sulphur with barium, calcium, strontium, magnesium, or aluminium) added and mixed with varnish.

To Color Powders with Aniline Colors.—Add hydrochloric acid to a dilute solution of water glass, as long as any precipitate of silica is thrown down, transfer the later to a filter and wash as long as it continues to absorb soluble matter. A solution of an aniline color is then poured over the precipitate; the coloring substance will be almost completely retained by the silica acid; after the precipitate has been dried we have a colored powder which can be ground up with dissolved glue or gum for use in printing wall papers, etc.

Aluminium Solder (according to M. H. Laucon)—Melted aluminium is covered with a layer of phosphoric acid, acid sodium sulphate, or other acid salts, and then the metals serving as solder added. Aluminium Solder for Wire and Their Objects—95 parts aluminium, 1 part copper, 4 parts tin, 95 parts aluminium, 1 part copper, 2 parts bismuth, 1 part zinc, 1 part tin; solder for larger objects, 95 parts aluminium, 2 parts copper, 2 parts antimony, 1 part bismuth, 1 part zinc; 60 parts aluminium, 13 parts copper, 15 parts antimony, 10 parts bismuth, 2 parts tin.

Colored alcohol flames for stage purposes, funerals, etc. Dissolve, according to the intensity of color, the flame is to display, in a mixture of 90 per cent alcohol and petroleum, 5, for white, chloride of zinc or chloride of magnesium; yellow, nitrate of ammonia, Chile saltpeter or common salt; pink and orange, chloride of calcium, chloride of lithium, separate or mixed, possibly with the addition of chloride of strontium and dissolved in the strongest alcohol; red, chloride of strontium; pale green, boracic acid; dark green, chloride of copper; violet, chloride of copper poured on to cotton wool soaked with ammonia; by the addition of chloride of strontium, chloride of calcium or chloride of lithium, the shading of the violet flame may be effected; dark blue, mountain blue or blue carbonate of copper kneaded into tow, soaked in alcohol, and some ammonia poured over it; faded pale blue, 90 per cent alcohol, with no addition. The solutions are either allowed to burn by themselves, in earthenware saucers or bunches of dry tow are placed in them, to serve as wicks.

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